The MINING CONGRESS JOURNAL

Volume 15 OCTOBER, 1929 *No. 10*

IRON ORE NUMBER

featuring

THE CLEVELAND-CLIFFS IRON COMPANY

and its extensive operations in the

LAKE SUPERIOR DISTRICT

The MESABI IRON RANGE

MARKET RESULTS of MERGERS

ACTIVITIES of the BUREAU of MINES in the LAKE SUPERIOR IRON ORE DISTRICT

The SCHOOL of MINES of the UNIVERSITY of WEST VIRGINIA

The HAULAGE FACTOR in MECHANICAL LOADING

AUXILIARY VENTILATION on BUTTE ENTRY WORK

WASTE DISPOSAL SYSTEM of the SPLASH DAM COAL CORPORATION

VENTILATION of ANACONDA'S BUTTE MINES

ANACONDA'S ZINC OPERATIONS and the DEVELOPMENT of COMPLEX ORES

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William G. Mather, S. R. Elliott, E. L. Derby, Jr., Lucien Eaton, W. W. Graff, Carl Brewer, Max H. Barber, H. C. Bolthouse, G. R. Jackson, W. H. Moulton, H. R. Harris, A. E. R. Schneider, William Conibear, A. D. Carlton, L. E. Ives, Dr. E. J. Hudson, John M. Bush, W. L. Taylor, C. E. Lawall, Russel B. Caples, C. K. West, G. B. Southward, A. S. Richardson.

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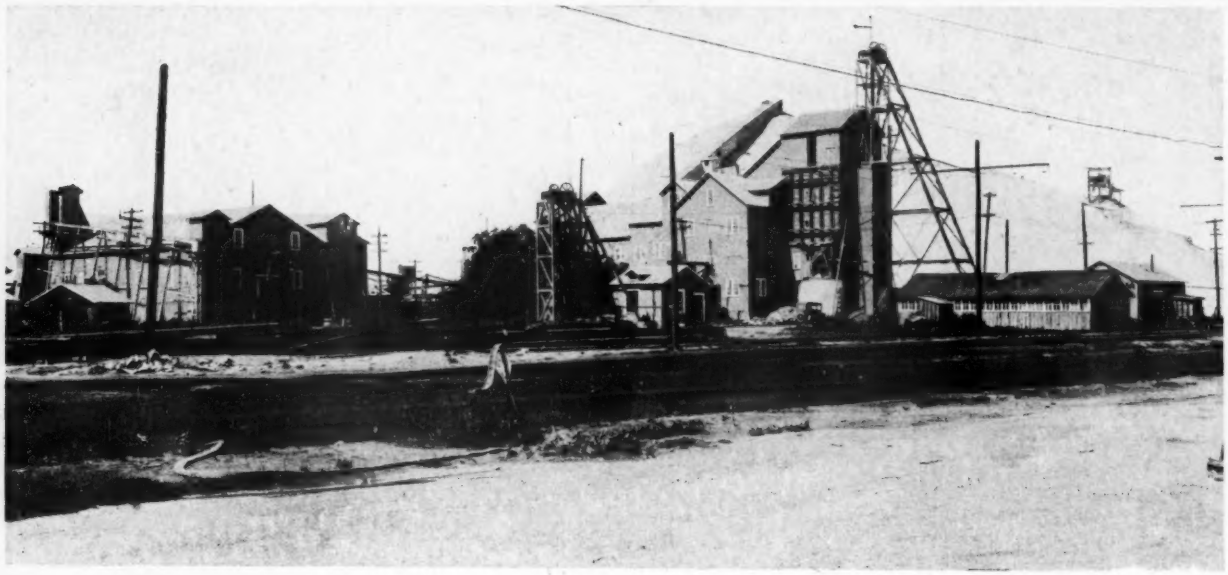

The Netta Mill of the Eagle-Picher Lead Company, at Picher, Okla.

To graphically present a complete picture of the lead and zinc industry from exploration, through the mining and milling cycle, to its important economic status is the special purpose of next month's Mining Congress Journal. The Eagle-Picher Lead Company's operation will be specially featured in this valuable series of articles. Single issues $1.00. Yearly subscriptions $3.00. Place your order for extra copies early—the demand will be heavy.

LEAD AND ZINC

The Flow of Lead Into World Trade, 1928
By ELMER W. PHERSON, Mining Engineer, Common Metals Division, U. S. Bureau of Mines.

Research and Market Broadening by Zinc Institute
By THEODORE MARVIN, Explosives Engineer.

Accident Prevention in Tri-State District
By HENRY GIESSING, Safety Engineer, Commerce Mining & Royalty Co.

Aerial Mosaic Map of Oklahoma Lead and Zinc Mining District
By CHAS. F. WILLIAMS, District Mining Supervisor, U. S. Geological Survey, Miami, Oklahoma.

Phelps Dodge Lead Smelter
By J. OWEN AMBLER, Superintendent, Copper Queen Branch, Phelps Dodge Corporation.

Mining Methods in Tri-State District
By R. E. ILLIDGE, Superintendent Netta Mine.

Recent Developments in Milling
By C. O. ANDERSON, Metallurgist, Century Zinc Co.

A Large Factor in Lead Industry
By A. E. BENDELARI, President, Eagle-Picher Lead Co.

Exploration Methods
By R. K. STROUP, Eagle-Picher Lead Co.

Surface Plant at Typical Operation
By S. S. CLARKE, Eagle-Picher Lead Co.

Milling
By F. W. SANSOM, Eagle-Picher Lead Co.

Safety and Industrial Relations
By O. N. WAMPLER, Safety Director, Eagle-Picher Lead Co.

Lead in Idaho
By STANLY A. EASTON, General Manager, Bunker Hill & Sullivan Mining && Concentrating Co.

The Importance of Zinc in Industry
By A. P. COBB, Vice President, New Jersey Zinc Co.

Paper Unannounced
By R. M. ROOSEVELT, Vice President, Eagle-Picher Lead Co.

The Mine Manager's Safety Problem
By HOWARD I. YOUNG, Vice President, American Zinc, Lead & Smelting Co.

IN THE NOVEMBER ISSUE OF The MINING CONGRESS JOURNAL

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Castian, Michigan

Car maintenance costs are reduced to a minimum.

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RandS Rotary Car Dumpers permit the use of Solidbody Cars, which cost less, have a greater capacity and require a minimum of maintenance. They are made in sizes to handle from 150 to 1500 tons per hour and for dumping from 1 to 35 cars at a time, handling cars of from 1 to 100 tons capacity and are used for dumping cars of every shape, size and kind.

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Maximum reductions in handling and dumping costs are obtained.

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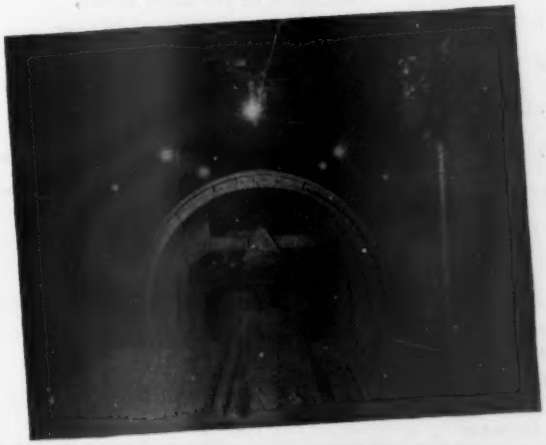
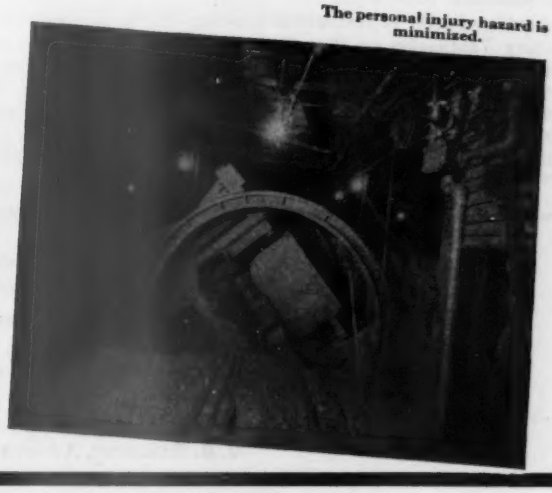


The personal injury hazard is minimized.



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The MINING CONGRESS JOURNAL

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Practical Operating Men's Department

COAL

Auxiliary Ventilation on Butt Entry Work

Waste Disposal System of the Splash Dam Coal Corporation

METAL

Ventilation of the Butte Mines, Anaconda Copper Mining Company

Anaconda's Zinc Operations and the Development of Complex Ores

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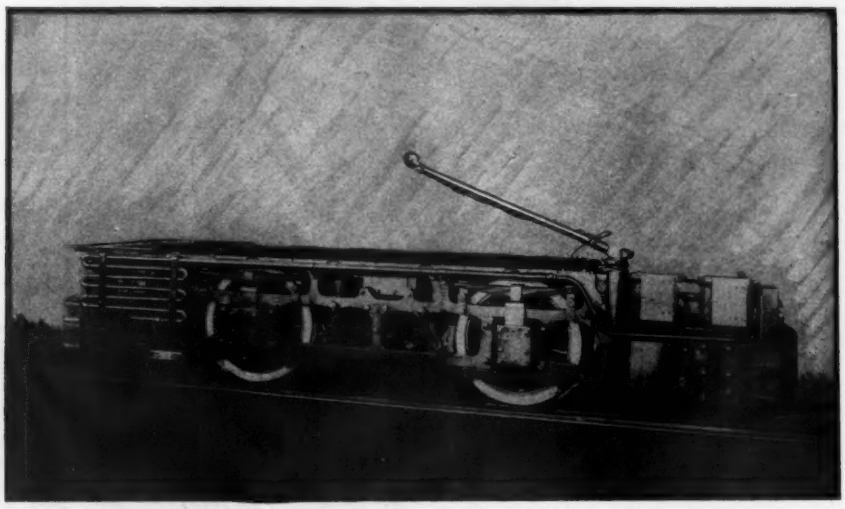
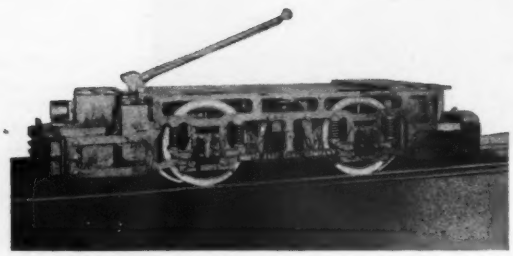
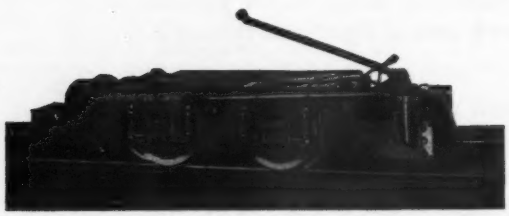


13-ton Baldwin-Westinghouse Trolley Haulage Locomotive of the Houston Collieries Company.



10-ton Baldwin-Westinghouse Trolley Haulage Locomotive of the North East Coal Company.



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GREATER tonnages per train at higher train speeds, lower maintenance costs, and the utmost reliability, are inherent characteristics of Baldwin-Westinghouse mine haulage locomotives.

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Bill: No—safety pins.

Skinny: For the love of Pete, what's them for? I thought this machine was out of the infancy stage long ago.

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Skinny: Gosh No—why?

Bill: Cause both save a lot of howls.

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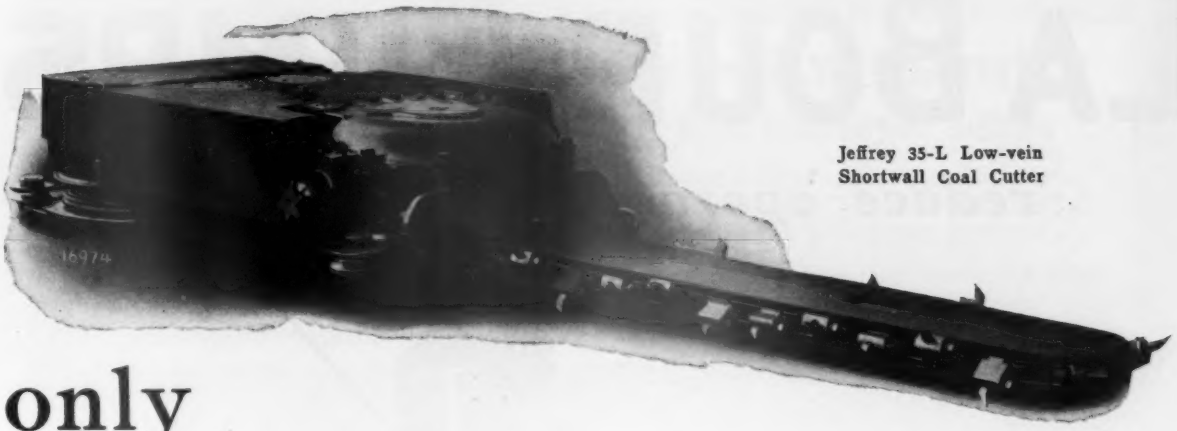

Jeffrey 35-L Low-vein
Shortwall Coal Cutter

only 18" over all height

The features of simple rugged construction, few gears, convenient location of operating levers and wheels, found in the Jeffrey 35-B and 35-BB Shortwall Machines are also found in this new Jeffrey 35-L Low-vein Shortwall.

The overall height of the machine itself is 18", overall width 44¾", and overall length exclusive of cutter bar 6′ 8⅝". Overall height on standard handitruck is 34½", and on standard low vein handitruck 26". The machine is equipped with a 50 hp. motor. Cutter bars are of standard lengths.

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A complete description of this new Jeffrey 35-L Low-vein Shortwall Machine will be gladly sent on request.

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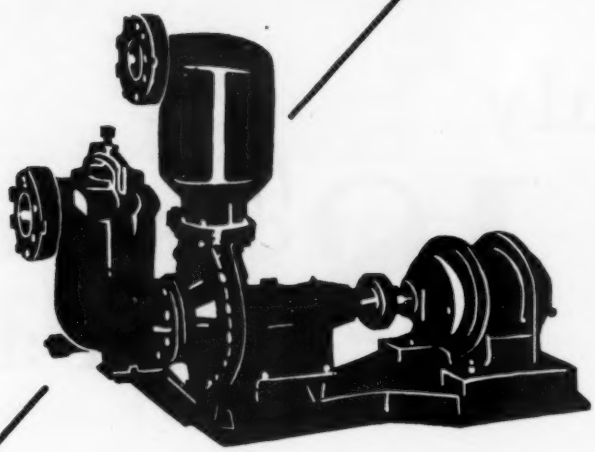
reduce operating expenditures



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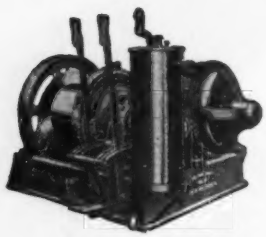

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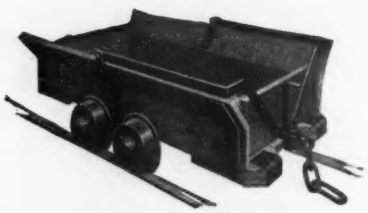

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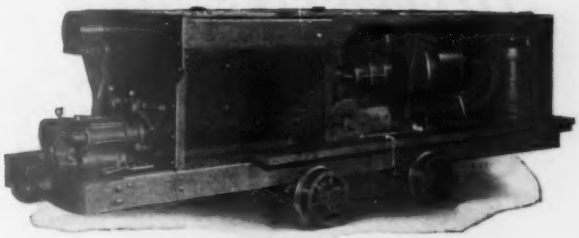

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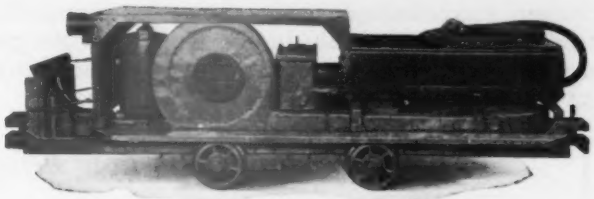

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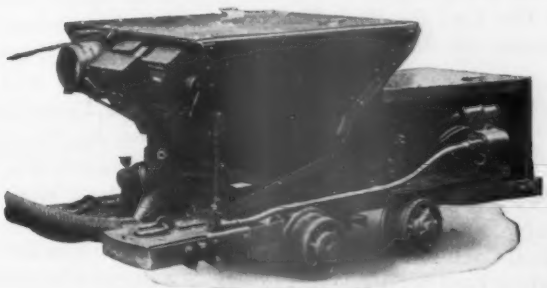

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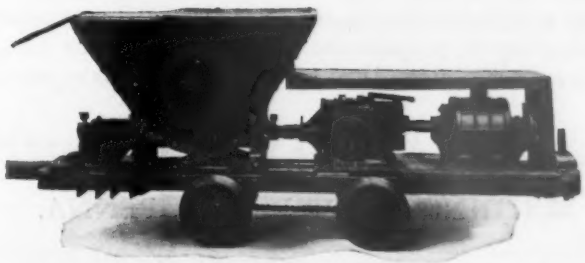

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Braddock, Thomas and Meade Sts.
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The four new plants now being erected are:—

1. *American Rolling Mill Company, Nellis, W. Va.* A complete Cleaning Plant for washing 200 tons per hour of 3½" x 0" No. 2 Gas Coal for High Grade Gas Producers and Steam Coal.

2. *Youngstown Sheet and Tube Company, Nemacolin, Pa.* The new Nemacolin Cleaning Plant of the Buckeye Coal and Coke Company is being designed to wash 600 tons per hour of 4" x 0" Pittsburgh No. 8 Seam for High Grade Metallurgical Coal. This is the largest metallurgical coal washery in the United States.

3. *Koppers Coal Company, Carswell, W. Va.* A new Koppers-Rheo Washery for washing 250 tons per hour of 5" x½" Pocahontas Coal for the domestic and metallurgical markets.

4. *Lehigh Valley Coal Company, Wilkes-Barre, Pa.* The new Dorrance Breaker complete with a 3000 ton per 8 hour day Head House and Breaker,—in which the Rheolaveur process is utilized to clean all sizes from Egg to No. 4 Buckwheat inclusive (3½" x 3-64"). This is a repeat installation.

This Company is prepared to accept full responsibility for the design, construction and operation of any coal cleaning or preparation plant of any size or capacity to meet your individual requirements. Koppers-Rheo *engineers* are *always at your service.*

KOPPERS-RHEOLAVEUR COMPANY

1150 KOPPERS BUILDING · PITTSBURGH, PENNA.

Sales Office
120 Broadway, New York, N. Y.

Sales Office and Laboratory
Coal Exchange Building, Wilkes-Barre, Pa.

The RHEOLAVEUR COAL WASHING PROCESS is helping these well-known producers to

{1} Satisfactorily meet the precise specifications of the individual coal buyer.

{2} Standardize subsequent deliveries to that individual buyer.

{3} Obtain increased yield of marketable coal with a greater proportion of larger sizes,—a higher realization in dollars per ton.

{4} Obtain low investment in preparation plant and low operating costs consistent with high washing efficiency and substantial, low-maintenance cost structure and equipment.

The broad experience of the Koppers-Rheo organization is always at your call, why not have one organization,—Koppers-Rheo—assume full responsibility for the investigation, design, construction and initial operation of your next Preparation Plant? You can depend upon having a "Modern" plant if it is a Rheo plant.

KOPPERS-RHEOLAVEUR COMPANY

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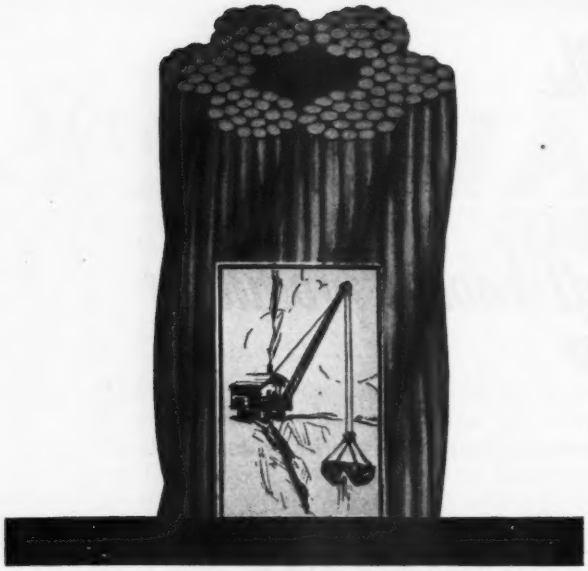
120 Broadway, New York, N. Y.

Sales Office and Laboratory
Coal Exchange Building, Wilkes-Barre, Pa.

First National Bank Building
Huntington, W. Va.

American Traders Bank Building
Birmingham, Ala.



There Are Many Grades *of* Wire Rope

but it's the Right Grade for the Job that Counts!

Solve your Wire Rope problems by using—

AMERICAN

STEEL & WIRE COMPANY

WIRE ROPE

American Steel & Wire Company

Subsidiary of United States Steel Corporation

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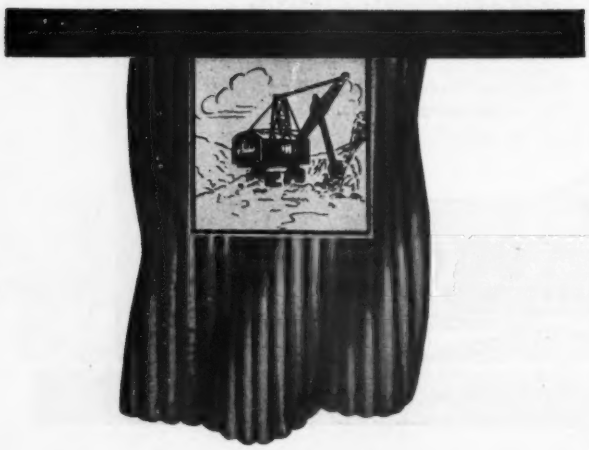
Export Representatives:
UNITED STATES STEEL PRODUCTS CO., 30 Church St., New York, N. Y.

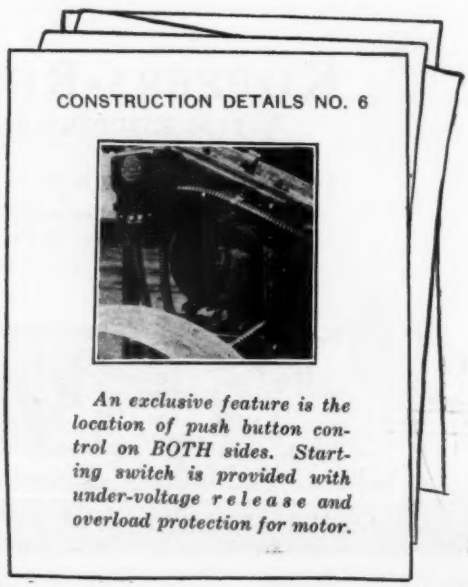


The MT. VERNON PIT CAR LOADER *for*

low cost mechanization

THAT pit car loading is an important development in mechanization is proven by the recent widespread use made of this method of mining. Use of Mt. Vernon Loaders offers the great advantage of mechanical mining—speed—combined with selective loading and easy operation in a machine that offers a maximum of advantages of operation. Send for details of the operation and construction of this, the more complete, pit car loader.

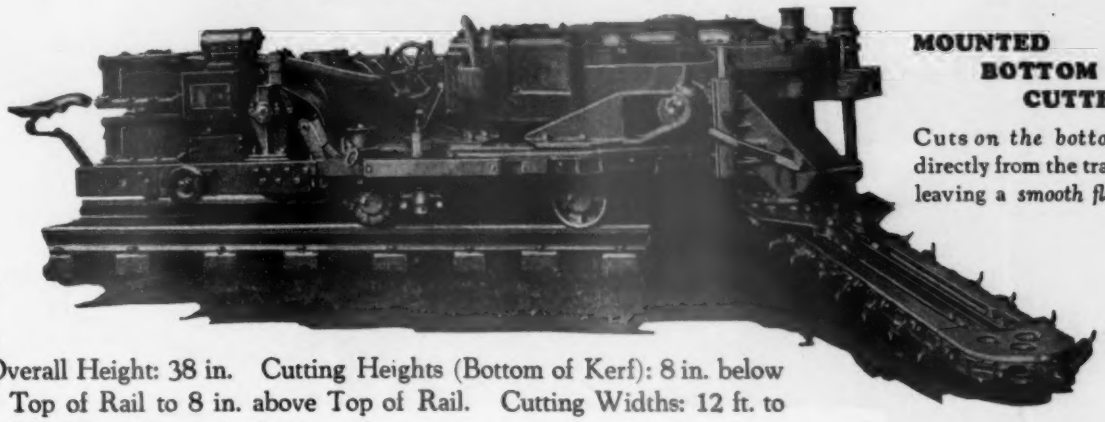
THE MT. VERNON CAR MFG. CO.
MT. VERNON ILLINOIS


CONSTRUCTION DETAILS NO. 6
An exclusive feature is the location of push button control on BOTH sides. Starting switch is provided with under-voltage release and overload protection for motor.

Goodman Slabbing Machines

"Stand the Gaff" in Tough Mine Service!

Because—They are Rugged, Safe and Easy to Operate, the Men Like Them, and They Cut Lots of Coal.

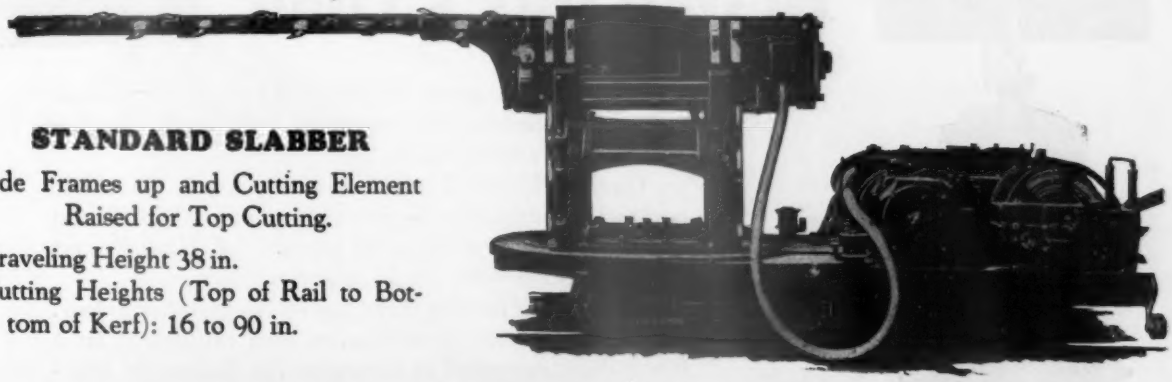


MOUNTED BOTTOM CUTTER

Cuts *on the bottom* directly from the track, leaving a *smooth floor.*

Overall Height: 38 in. Cutting Heights (Bottom of Kerf): 8 in. below Top of Rail to 8 in. above Top of Rail. Cutting Widths: 12 ft. to 28½ ft., with standard 7-ft. undercut arm.

No bothersome ropes or sheaves used for cutting across; no unloading of machine from a truck; no dragging to face; no dragging back to truck; no reloading onto truck; scrapping of bottom greatly reduced.

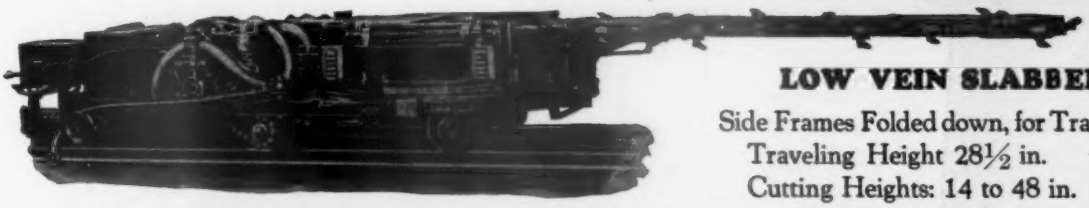


STANDARD SLABBER

Side Frames up and Cutting Element Raised for Top Cutting.

Traveling Height 38 in.

Cutting Heights (Top of Rail to Bottom of Kerf): 16 to 90 in.



LOW VEIN SLABBER

Side Frames Folded down, for Traveling.

Traveling Height 28½ in.

Cutting Heights: 14 to 48 in.

Their surpassing ability to **Do Hard Work** and **Endure Severe Punishment** has been a big factor in the phenomenal success of the Goodman Line of Slabbing Machines

Specifications and Features for all three types are in Book No. 280—Yours upon Request

(9)

GOODMAN MANUFACTURING COMPANY
HALSTED ST. at 48TH.
CHICAGO - - - ILL.

Locomotives - Loaders - Coal Cutters

PITTSBURGH—HUNTINGTON, W.VA.—CINCINNATI—BIRMINGHAM—ST. LOUIS—DENVER—PRICE, UTAH

Two Days' Work In One Day's Time

WHEN days grow shorter—when dark hours crowd out productive operation—speed up your job with a night shift.

Carbic Flood Lights are powerful, portable units that supply clear white perfectly diffused light. They are rugged pieces of equipment built to serve you night after night.

Carbic Light requires no costly installation. Any inexperienced workman can charge it in a few minutes—and it is ready for hours of continuous service.

Carbic Light costs only a few cents an hour.

Extend Your Working Day With
CARBIC LIGHT

OXWELD ACETYLENE COMPANY

Unit of Union Carbide and Carbon Corporation

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Carbic is distributed by the Union Carbide Sales Company through its national chain of warehouses and is sold by jobbers everywhere.

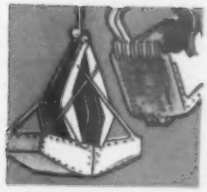
Technical Publicity Department, Oxweld Acetylene Company
205 East 42nd Street, New York, N. Y.

Without obligation, I would like to have additional information on Carbic Lights.

Name.....

Street Address.....

City..... *State*.....

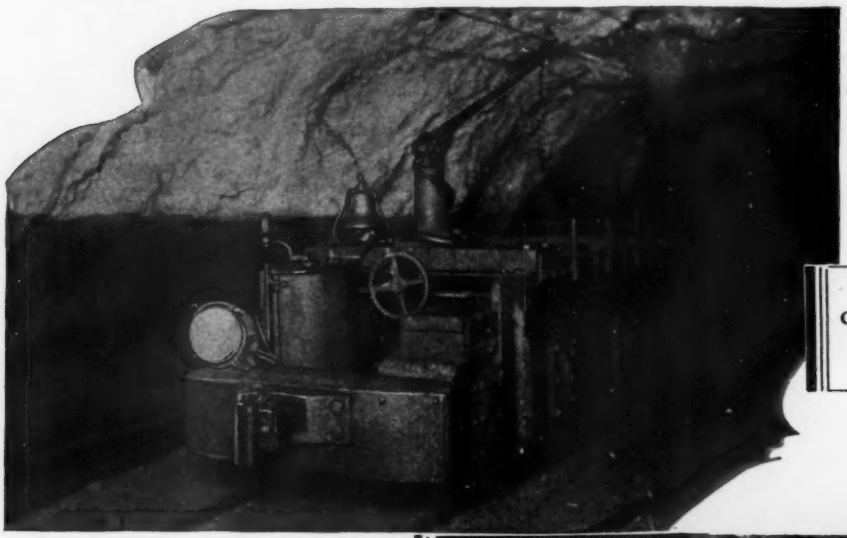


IRON ORE

MINING EQUIPMENT

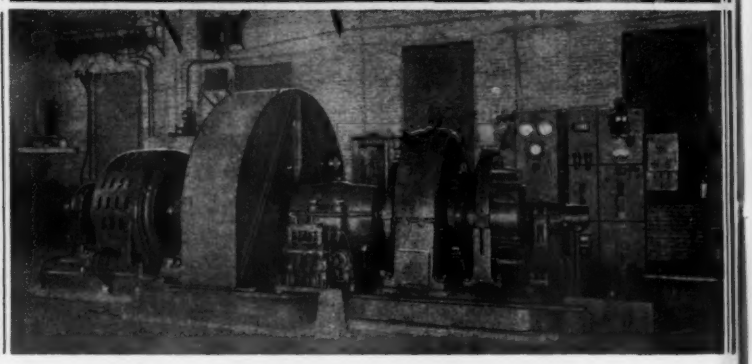
VK510 .O6 2
XUM

From Mine to Surface



G-E six-ton trolley locomotive, Cliff Shaft Mine

G-E motor driving plunger pump on fourth level, Holmes Mine



G-E flywheel motor-generator set, for Ilgner-Ward Leonard hoist, Athens Mine

Apply the proper G-E motor and the correct G-E controller to a specific task, following the recommendations of G-E specialists in electric drive, and you have G-E Motorized Power. Built in or otherwise connected to all types of industrial machines, G-E Motorized Power provides lasting assurance of performance that builds confidence.

GE Motorized Power
-fitted to every need

GENERAL

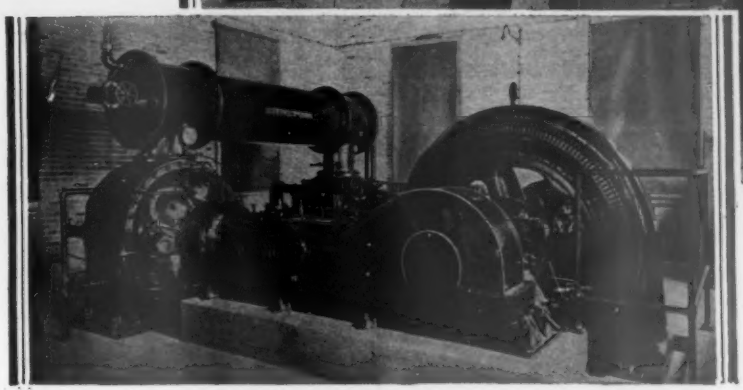
GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

Electricity aids the Cleveland-Cliffs Iron Company

G-E LOCOMOTIVES and G-E motorized compressors, hoists, and pumps, supplied by G-E generating, transforming, and converting equipment, are facilitating production in many mines of the Cleveland-Cliffs Iron Company.

General Electric is prepared to supply equipment for any phase of mine electrification. The nearest G-E office will gladly assist you with your power problems.

G-E motorized cage hoist, Athens Mine



G-E motor driving 2440-cu.-ft. compressor, Negaunee Mine

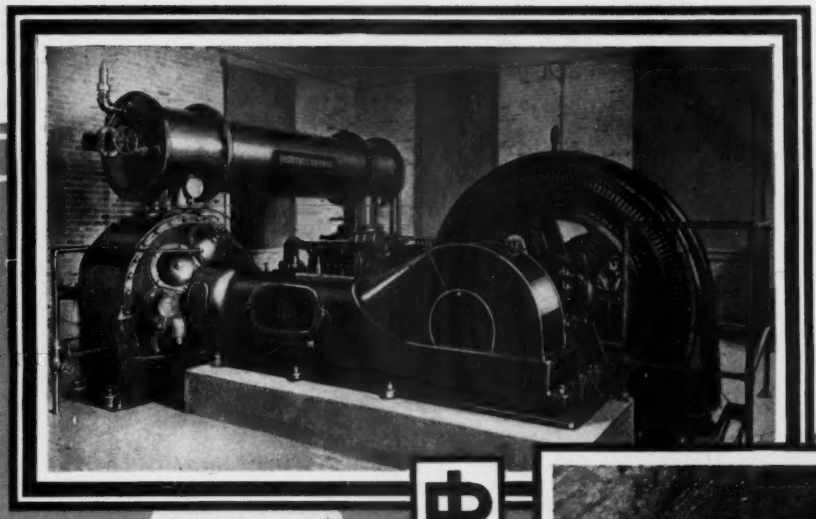
JOIN US IN THE GENERAL ELECTRIC HOUR, BROADCAST EVERY SATURDAY AT 9 P.M., E.S.T. ON A NATION-WIDE N.B.C. NETWORK

200-309

ELECTRIC

SALES OFFICES IN PRINCIPAL CITIES

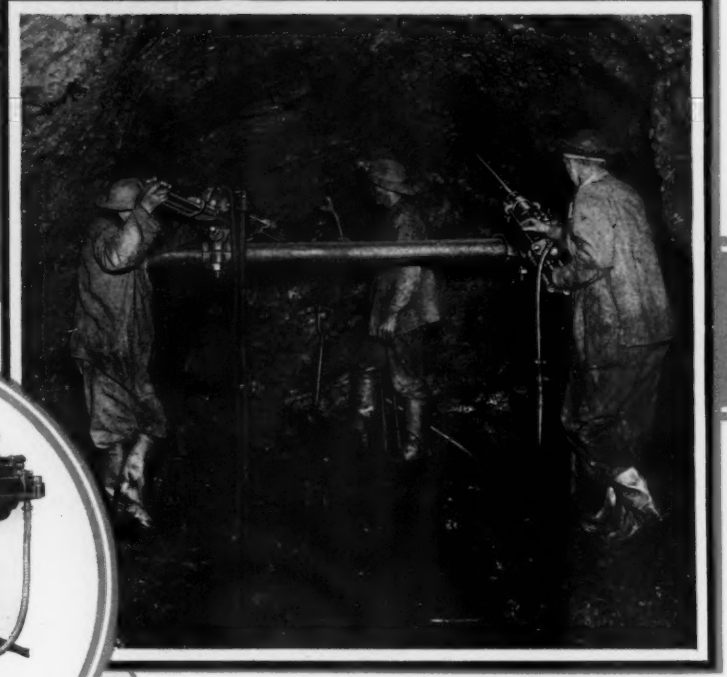
To The Cleveland Cliffs



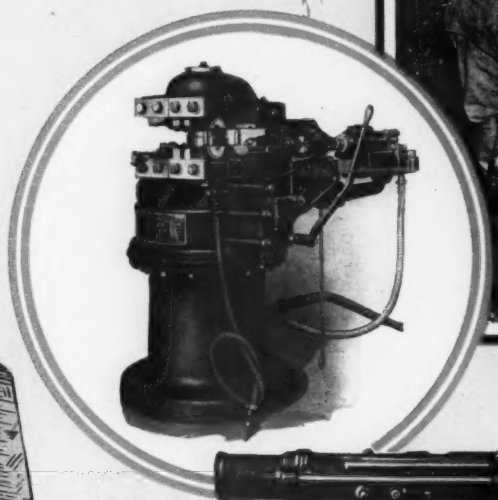
Ingersoll-Rand PRE Compressor at the Negaunee Mine of the Cleveland Cliffs Iron Company.

We take this opportunity to congratulate your organization upon the development of one of the largest and foremost groups of underground iron ore mines in the world.

We appreciate the consid-



Driving a heading at the Cliffs Shaft mine with two I-R drifter drills mounted on a shaft bar.



I-R No. 50 sharpener

N-75 drifter type drill

I-R Equipment

ROCK DRILLS: In hematite deposits, auger steel actuated by a "Jackhamer" drill accomplishes the work that formerly required eight or more men. For shaft-sinking, block-holing, and other jobs "Jackhamers" are unequalled.

Drifting and stoping drills are available in sizes and models suitable for every phase of mining work.

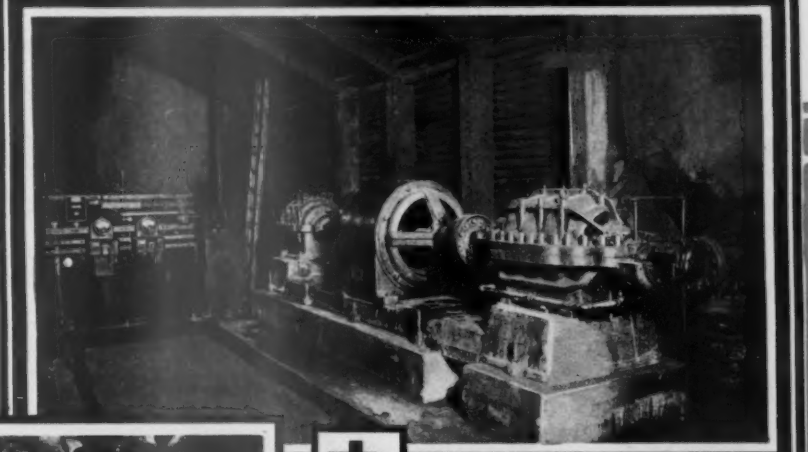
COMPRESSORS: An efficient air-producing plant is essential if productive mining is to be carried on. Ingersoll-Rand Compressors, long noted for their reliability and economy, are made in more than one thousand types and sizes.

There is an Ingersoll-Rand Branch near you. At this Branch you can obtain expert engineering assistance, competent mechanical service and prompt deliveries of complete machines and spare parts.

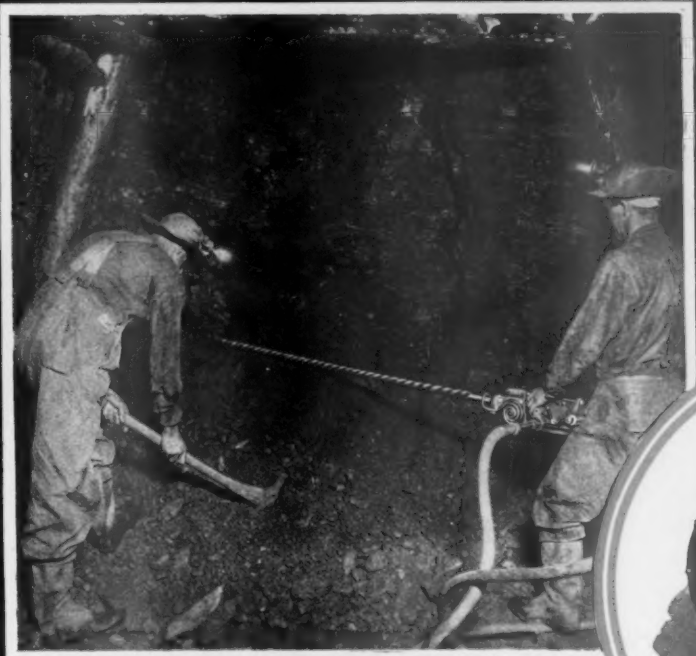
Atlanta	Butte	Denver	Hartford	Newark	Pittsburgh	Scranton
Birmingham	Chicago	Detroit	Joplin	New Orleans	Pottsville	Seattle
Boston	Cleveland	Duluth	Knoxville	New York	Salt Lake City	St. Louis
Buffalo	Dallas	El Paso	Los Angeles	Philadelphia	San Francisco	Washington

Iron Company of Michigan

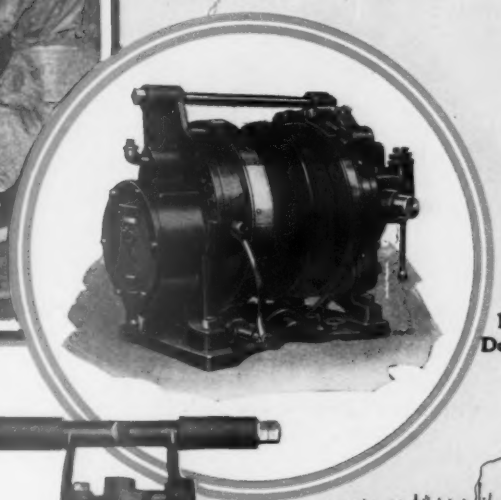
eration that you have shown our representatives during the many years that you have been operating, and we are proud to feel that Ingersoll-Rand equipment has contributed in some measure to your success.



A Cameron multi-stage pump at the Holmes mine on the Marquette Range.



I-R "Jackhamer" using auger steel at the Athens mine. This type of drill plays a large part in the production of iron ore.



No. 6HC Double-drum hoist

for Iron Mines

SHARPENER EQUIPMENT: Sustained performance by drilling crews calls for true and uniform steels. Ingersoll-Rand blacksmith equipment insures the accuracy of bits and shanks, which makes for speed and economy in drilling.

The I-R oil furnace for heating steel is economical, clean, and entirely safe.

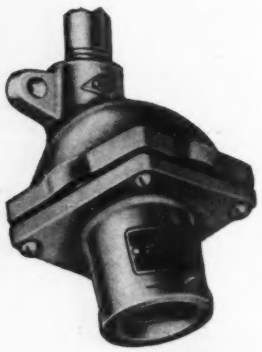
"LITTLE TUGGER" HOISTS: For hauling ore to the chutes or up inclined ways to cars, these sturdy, powerful machines are unexcelled in iron-mining. Strong points in their favor are their economy, safety, dependability, portability, and ease of operation.

Ingersoll-Rand

11 Broadway, New York

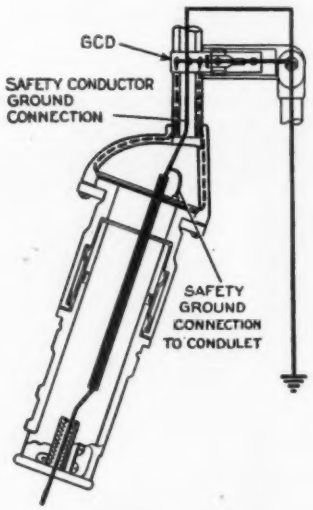
"ARKTITE" CIRCUIT-BREAKING PLUGS AND RECEPTACLES

With Complete Safety Circuit Ground Protection



Type QEE "Arktite' Condulet with "Arktite" Plug and Receptacle

2, 3, and 4 Poles
Up to 600 Volts
10 to 200 Amperes



"Arktite" Plug and Receptacle showing Path of Ground

Complete information will be furnished upon request

Arktite plugs and receptacles embody an entirely new principle in plug and receptacle construction which meets the demand for circuit-breaking plugs and receptacles in capacities heretofore considered impracticle.

As the name implies, the arc formed by pulling the plug is so completely confined in a chamber of insulating material that it is impossible to form a short circuit or ground.

CROUSE-HINDS

ESTABLISHED 1897

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MILWAUKEE

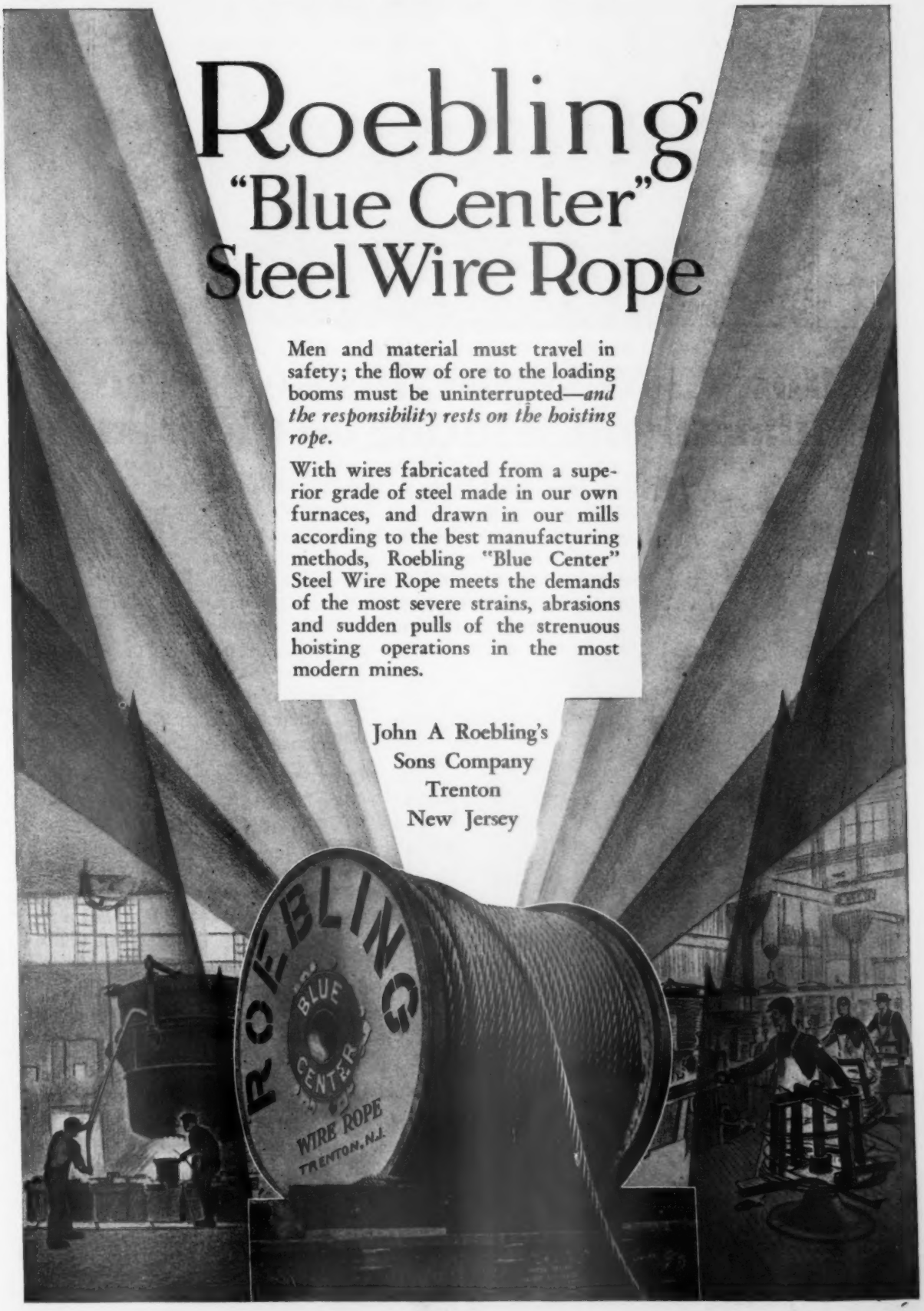
C-H434

Roebling "Blue Center" Steel Wire Rope

Men and material must travel in safety; the flow of ore to the loading booms must be uninterrupted—*and the responsibility rests on the hoisting rope.*

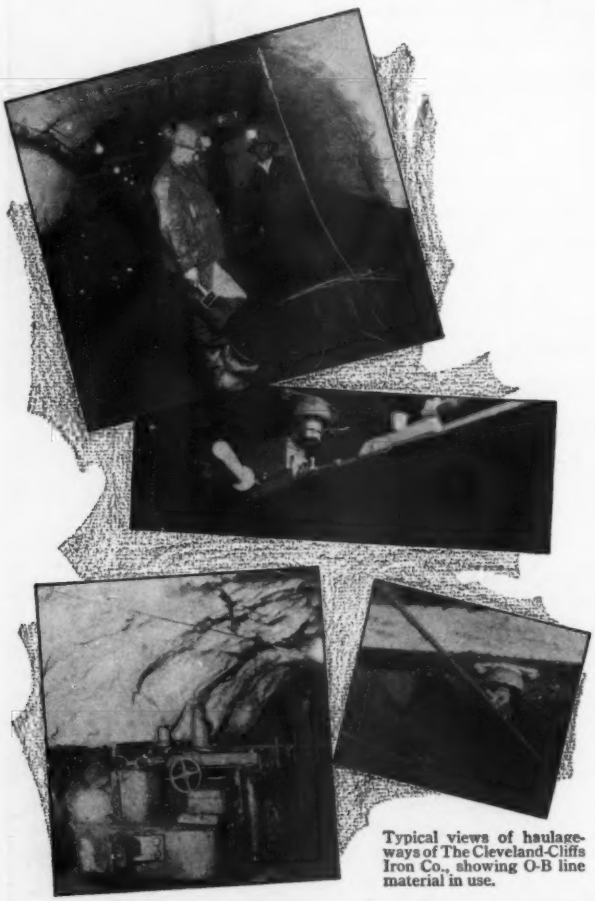
With wires fabricated from a superior grade of steel made in our own furnaces, and drawn in our mills according to the best manufacturing methods, Roebling "Blue Center" Steel Wire Rope meets the demands of the most severe strains, abrasions and sudden pulls of the strenuous hoisting operations in the most modern mines.

John A Roebling's
Sons Company
Trenton
New Jersey



Cliffs shaft mine, Ishpeming, Michigan.

How Cleveland-Cliffs keeps the "Dollars from Waiting on the Dimes"



Typical views of haulageways of The Cleveland-Cliffs Iron Co., showing O-B line material in use.

A train of loaded mine cars often represents hundreds of dollars in expense to get the ore even as far as the mine cars. Then the proposition is to keep it moving. Every minute delay adds to the cost. How discouraging it must be to have a train of ore held up because of trouble in the haulageway. Here is truly "a dollar waiting on a dime". Just think, a train load of ore costing hundreds of dollars is held up just because a line material device costing but a dime in comparison has fallen down on the job and caused the delay.

Like all other well-managed companies, The Cleveland-Cliffs Iron Company makes a successful effort to keep the dollars from waiting on the dimes. In their haulageway, nothing but line material items with a proved record for dependable service are used. It is not strange then that one should find O-B line material used extensively at The Cleveland-Cliffs Iron Co. In their haulageways thousands of O-B hangers, clamps, splicers and rail bonds have been in service for years giving that steady, reliable, and trouble-free service that keeps "dollars from waiting on dimes".

Ohio Brass Company, Mansfield, Ohio
Canadian Ohio Brass Co., Limited
Niagara Falls, Canada
1125M

Ohio Brass Co.

NEW YORK PITTSBURGH PHILADELPHIA BOSTON CHICAGO CLEVELAND ST. LOUIS ATLANTA SAN FRANCISCO LOS ANGELES DALLAS

PORCELAIN INSULATORS
LINE MATERIALS
RAIL BONDS
CAR EQUIPMENT
MINING MATERIALS
VALVES

Derailments are costly

- - - end them!

MINE executives know only too well how frequently derailments occur on main haulage tracks, and how costly they are.

The Bethlehem (Keystone) Metal Tie eliminates derailments due to the rails spreading or "rolling over," because it holds the rails positively to exact gauge.

Although main haulage tracks can be equipped 100% with Bethlehem (Keystone) Metal Ties, in a great many cases they are used in conjunction with the present wooden ties, replacing every third or fourth wooden tie with a metal one. The metal tie acts as a gauge rod and is ample to hold the rails rigidly in position.

With this arrangement the wooden ties have only one duty to perform: to support the rails. All strain previously placed on the spikes is assumed by the steel ties. As a result, the full life of the wooden ties is assured.

Used in this way, the Bethlehem (Keystone) Metal Tie greatly prolongs the life of the wooden ties and prevents derailments due to spreading or "rolling over." One derailment saved will more than offset the cost of Bethlehem (Keystone) Ties at that location.

Write for literature describing the Bethlehem (Keystone) Tie in detail.

The Bethlehem (Keystone) Metal Tie is built for main haulage tracks in mines, quarries and industrial plants. It is rolled from high quality steel and the ends are pressed into "whale-tail" shape to grip the ballast.

The tie-plates, which are slotted to receive the rail clips, are riveted permanently to the tie. This heavy tie-plate acts as a reinforcement at the point where the load is carried and adds to Bethlehem (Keystone) Tie. the strength and life of the

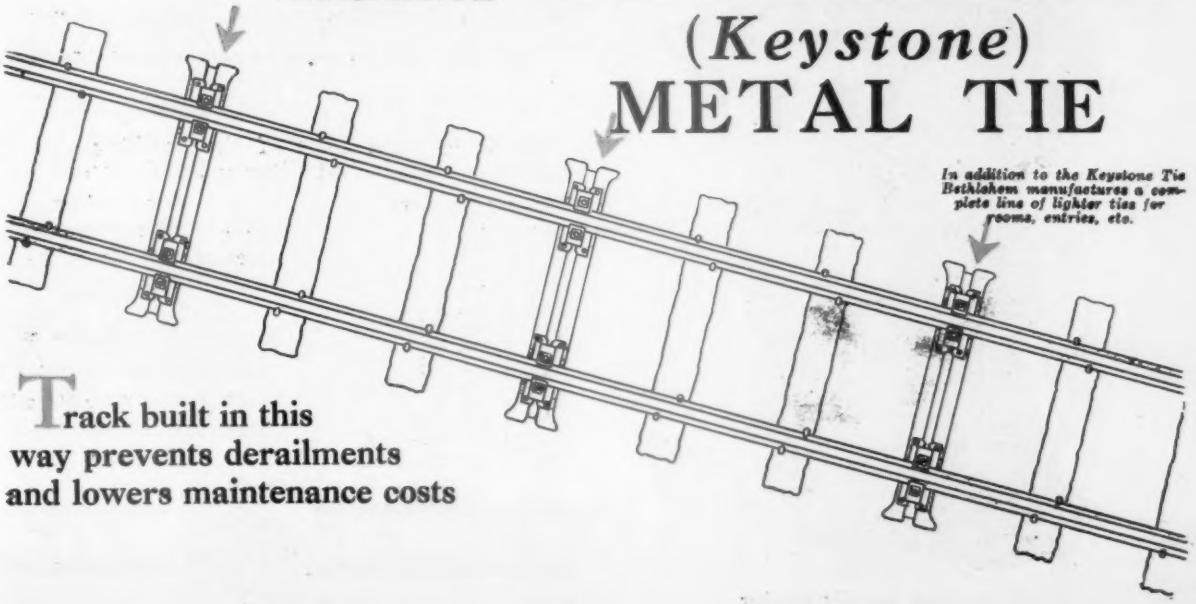
BETHLEHEM STEEL COMPANY

General Offices: Bethlehem, Pa.

District Offices: New York Boston Philadelphia Baltimore Washington Atlanta Pittsburgh Buffalo Cleveland Detroit Cincinnati Chicago St. Louis San Francisco Los Angeles Seattle Portland Honolulu

Bethlehem Steel Export Corporation, New York, Sole Exporter of our Commercial Products

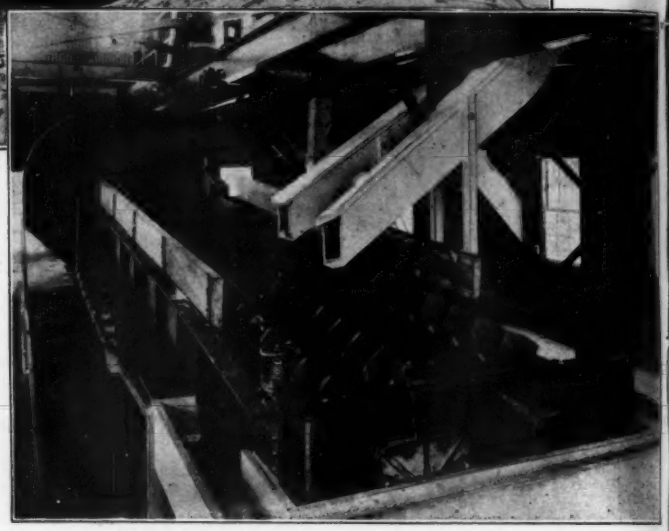
BETHLEHEM (*Keystone*) METAL TIE



In addition to the Keystone Tie Bethlehem manufactures a complete line of lighter ties for rooms, entries, etc.

Track built in this way prevents derailments and lowers maintenance costs

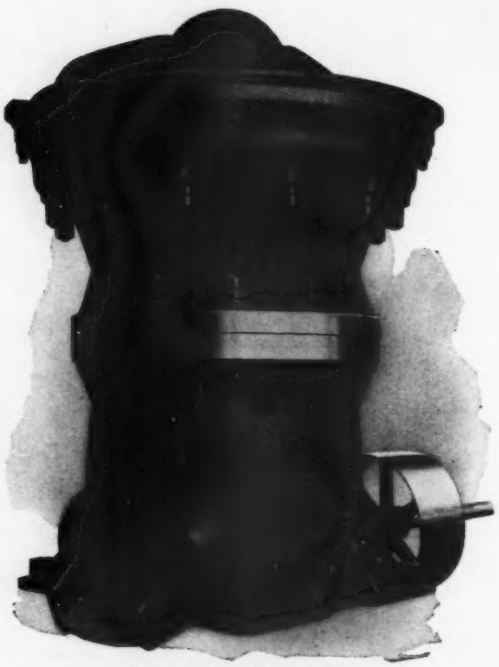
— at Cleveland-C



Above: Gwinn District Crusher, Gwinn, Mich., operating a 15-in. McCully Crusher and two Allis-Chalmers Pan Conveyors.

Below: 25-ft. Hutch Log Washer installed at Cleveland-Cliffs Washing Plant.

Allis-Chalmers equipment was first installed by Cleveland-Cliffs Iron Company forty-three years ago, starting a business relationship that has continued to the present time and that has been indicative of mutually beneficial results. Equipment has been supplied to Holmes, Gwinn, Maas, and Hill-Trumbull Mines, for the washing plant at Hill-Trumbull and for two hydro-electric plants for supplying power for operations.



Superior McCully Crusher

Below is listed some of the crushing and conveying machinery installed at Cleveland-Cliffs mines.

Gyratory Crushers

1901	1	No. 8
1905	1	No. 8
1909	1	No. 8
	2	No. 5
1912	2	No. 6
1915	1	No. 7½
	1	No. 6
1916	1	No. 7½
	1	No. 8
	1	No. 6
1917	1	No. 7½
1926	1	10″ Fine Red.
1928	1	10″ Fine Red.

Jaw Crushers

1919	1	42″ x 40″ for Hill-Trumbull
1920	1	42″ x 40″ for Maas Mine

Pan Conveyors

1916	1	8′ x 58′ for Gwinn Mine
1917	1	8′ x 58′ for Maas Mine
1919	1	8′ x 60′ for Hill-Trumbull
	1	5′ x 20′ for Hill-Trumbull

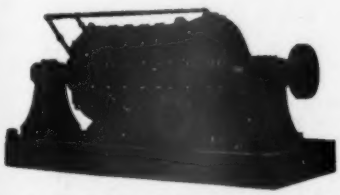
Cliffs

CRUSHERS
CONVEYORS
HOISTS
LOG WASHERS
CENTRIFUGAL PUMPS
TURBINES
GENERATORS
MOTORS

The Carp River Hydro-Electric Plant built in 1911 operates two Allis-Chalmers units of 4,000-h.p., 550-ft. head, 720-r.p.m. This plant ranks among the high head reaction turbine installations in the world. Its performance has been remarkable, as not a single replacement or repair was required up to 1929. A second plant with a vertical type unit was built for this company in 1923.

The skip hoist at Holmes Mine is shown above and the cage hoist at the right. These hoists have drums with 10-ft. width and 7-ft. face holding two 1¼-in. ropes each 1,500-ft. long. The skip hoist has a duty of 13,700-lbs. rope pull at 1,000-f.p.m. and the other 14,900-lbs. at 700-f.p.m.

Included with the twenty or more centrifugal pumping units furnished Cleveland-Cliffs have been a number of high lift multi-stage pumps, notably two 8-in., 6-stage pumps each for 1,000-g.p.m. capacity and 1,000-ft. head, driven by 400-h.p., 1,760-r.p.m. slip ring motors, installed in 1917.



Type of Multi-Stage Pump furnished Cleveland-Cliffs Iron Co.

THE equipment that Allis-Chalmers has supplied to the Cleveland-Cliffs Iron Company is representative of the ability of this company to serve iron mining companies. Many of the greatest washing plants in the country are further evidence. These plants make it practical to mine low grade ore that is not suitable for smelting in its original form. The process of washing raises the grade of hitherto unprofitable ore and makes it ready for smelting.

Allis-Chalmers Manufacturing Company has been a pioneer in the development of ore washing plants. This company is prepared to furnish complete equipment for washing plants as well as for other ore treatment plants. Its long experience as a manufacturer of mining, milling and power equipment, and the experience of its engineers with successful plants and field conditions are available to prospective builders of such plants.

Allis-Chalmers Manufacturing Company

MILWAUKEE, WISCONSIN

ALLIS-CHALMERS

MILWAUKEE, WIS. U.S.A.

BECKER TYPE OVENS of the Trumbull Cliffs Furnace Co.

The By-Product Coke Plant of the Trumbull Cliffs Furnace Company includes 64 of the Koppers Construction Company's Becker Type Ovens with an Annual Coal Capacity of 603,500 tons. Auxiliaries include a material handling plant, by-product and Benzol plants. ¶ Designed and built by the Koppers Construction Company, this plant is a complete operating unit.

KOPPERS
Construction Company

Chicago Pittsburgh New York

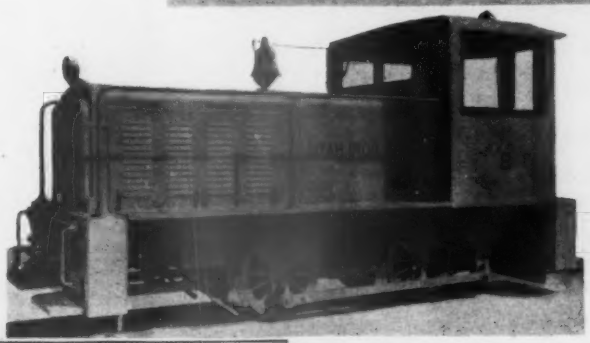
Offers a complete engineering service. It is prepared to make competent studies of coke plant projects, recommend, design and build appropriate new or auxiliary equipment and suggest the most efficient operating practice.

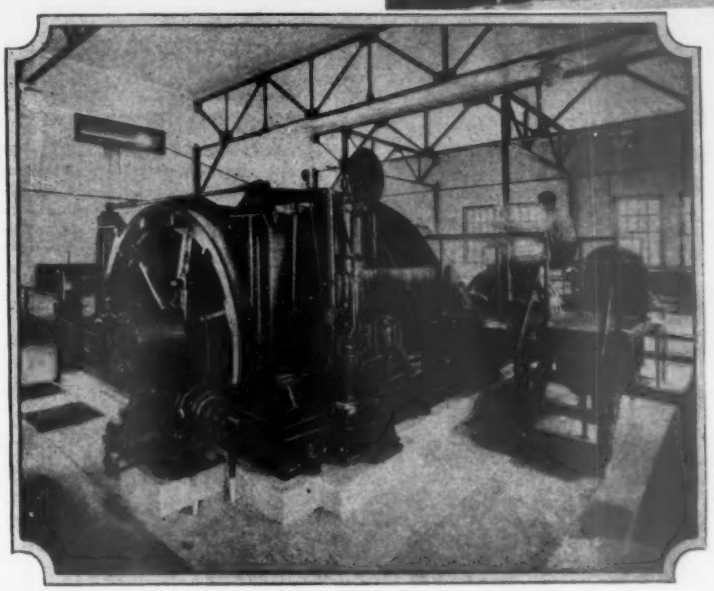
Koppers equipment includes . . . Becker Type Oven Plants - Continuous Verticals - Gas Producers - Water Gas Plants - Liquid Purification Plants - By-Product Equipment Gas Dehydration Plants - Material Handling Plants - Phenol Removal Plants, Etc.

FOR ECONOMICAL COKE PRODUCTION

In the production of IRON

Skips, cages and gunboats
Shaking chute conveyors
Gasoline locomotives
Electric locomotives
Steam locomotives
Ventilating fans
Electric hoists
Steam hoists
Sheave wheels
Rotary kilns
Ball mills





This 400-h.p. electric hoist, built for the Bates Iron Company, Iron River, Mich., is one of many types developed by Vulcan in over 80 years of hoist building.

Its operations conditions are:

Balanced shaft hoisting with skip on one side and cage on the other.

Maximum hoisting depth	2,000'.
Diameter of rope	1⅛".
Average rope speed	1,000 f. p. m.
Maximum unbalanced load	10,700 lbs.
Size of drum	10' 0" dia.
	8' 0" face.

Send for bulletins.

VULCAN of WILKES-BARRE, PA.
MINING EQUIPMENT

WHETHER open pit or underground VULCAN products offer a wide choice for exact selection for the needs of iron mining. Locomotives like the above are specially efficient for open pit mining—for short hauls with sharp curves. The compact steam locomotive, built for the Northwestern Iron Company, Mayville, Wis., is one of a type made to burn coal, wood, or crude fuel oil.

The heavy duty spur gear drive gasoline locomotive is particularly useful for short hauls, intermittent service or for use in bad feed-water districts. No fire banking or building up of steam necessary, they afford efficient, safe and cheap haulage. The 20-ton locomotive above was built for the Utah Iron Ore Corporation, Iron Springs, Utah.

There is a Vulcan Locomotive for every mining need—write for descriptive bulletins. Bulletins are available describing these and all other types of our mining material.

VULCAN IRON WORKS
WILKES-BARRE, PA.

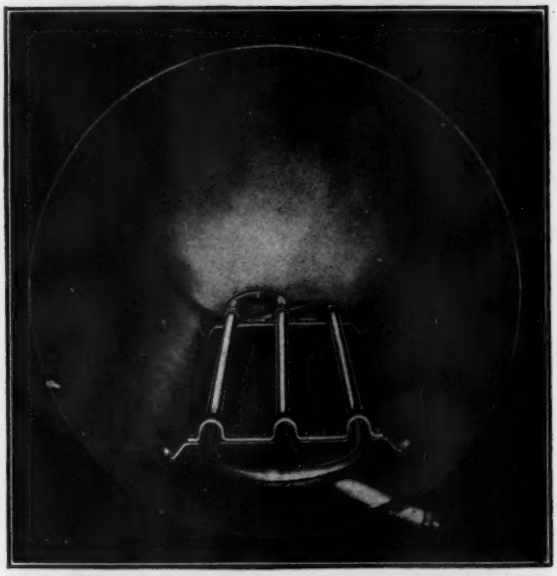
ALUMINUM
Tank Cars

The Cleveland-Cliffs Iron Company uses Alcoa Aluminum tank cars for transporting Glacial Acetic Acid because this modern metal resists the corrosive action of the acid and, therefore, causes no discoloration. Furthermore, it withstands the shocks, stresses and strains encountered in railroad transportation, and is light in weight.

Aluminum Company of America builds all kinds of equipment of Alcoa Aluminum and its alloys, and will be glad to furnish data concerning any kind of aluminum equipment.

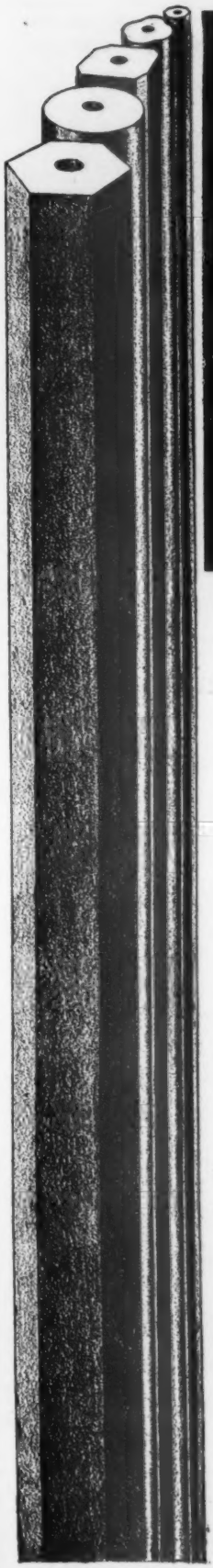
ALUMINUM COMPANY OF AMERICA
2499O Oliver Building Pittsburgh, Pa.
Offices in 19 Principal American Cities

ALUMINUM
In Every Commercial Form



ALCOA

ABOVE—Interior of one of the aluminum tanks showing steam pipe for liquifying the glacial acetic acid.



CRUSCA at Cleveland-Cliffs

Where the drilling is hardest and where the service is most severe are the places where good drill steel shows up to the best advantage. That is the reason great mining companies like The Cleveland-Cliffs Company have selected CRUSCA "New Process" Hollow Drill Steel for their use. Long experience has proven its uniform and dependable quality; that it has high fatigue value and high cutting ability; that its clean smooth finish has no tendency to crack or spread; and that it has great resistance to vibratory shock.

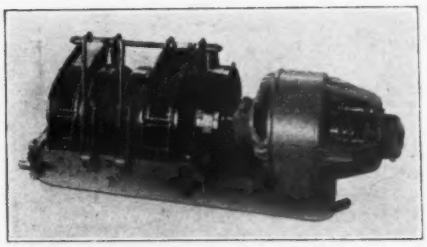
There is a CRUSCA drill for every drilling purpose. Distribution points in all principal cities—within quick reach of every important mining center.

CRUCIBLE STEEL COMPANY of America

General Offices: 17 East 42nd St., New York, N. Y

BRANCH OFFICES AND WAREHOUSES

Atlanta, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Hartford, Indianapolis, Milwaukee, New Haven, New York, Philadelphia, Pittsburgh, Providence, San Francisco, Seattle, Springfield, St. Louis, St. Paul, Syracuse, Montreal, Toronto, London, Tokio.



Scraper Hoist
for underground mining

Head Frame Sheave
for Iron Mines

Steel Mine Skip

Wood Distillation
Retorts

Just a few of the many products manufactured for the Mining, Furnace and Chemical departments of the Cleveland Cliffs Iron Company in Michigan.

Acetic Acid Still
and
Wood Retort Buggy

Lake Shore Engine Works

ENGINEERS—FOUNDERS—MACHINISTS

Marquette, Michigan

Where continuity of service is essential

ANACONDA TROLLEY WIRE

ANACONDA Trolley Wire is used in the Cleveland-Cliffs Mines as well as in many others of the largest mines throughout the country because the engineers in charge of operations have learned to rely on it for dependable, *uninterrupted* service.

Anaconda Trolley Wire is tough, strong and durable. Its conductivity is unexcelled because it is made of Anaconda Electrolytic Copper—over 99.9% pure.

Where the most durable trolley wire is required, and for permanent lines, Anaconda Wire & Cable Co. recommends Hitenso "A" and Hitenso "C." Actual tests have proved these trolley wires to be from two and one-half to three times as durable as hard drawn copper wire.

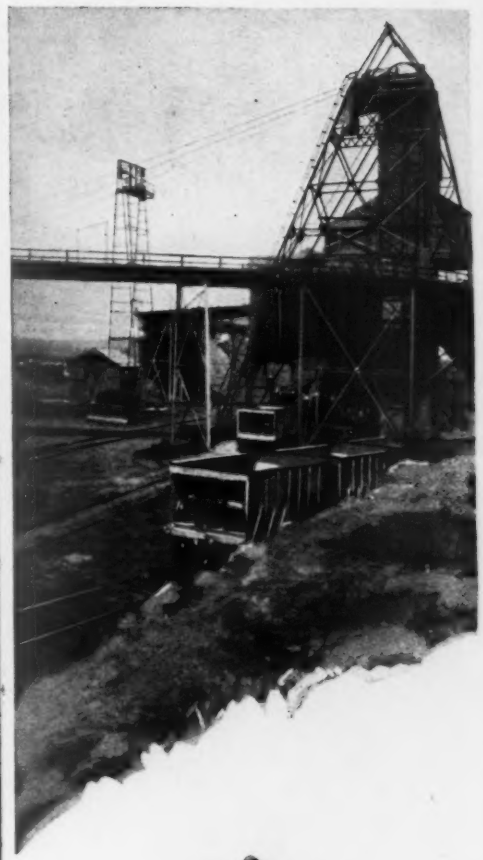
Hitenso "A" and Hitenso "C" meet the physical requirements of the A. S. T. M. Specifications for Medium Strength Bronze and High Strength Bronze respectively, but exceed the required conductivity by 15%.

Seven modern wire mills offer a coast-to-coast service unequalled for promptness and dependability. Complete information concerning the physical properties of Anaconda Trolley Wire is contained in Bulletin B-11, sent free upon request.

ANACONDA WIRE & CABLE CO.

General Offices: 25 Broadway, New York
Chicago Office: 111 West Washington St.

Exclusive Selling Agent for Wire and Cable Products of
THE AMERICAN BRASS COMPANY



ANACONDA

Other Anaconda Wire and Cable Products Used in Mining Operations

Copper Wire
Solid or Stranded
Bare or Weatherproof
Rubber Covered (Durawire*)

Power Cables
Power or V. C. Insulated
Lead Sheathed
Braid Covered

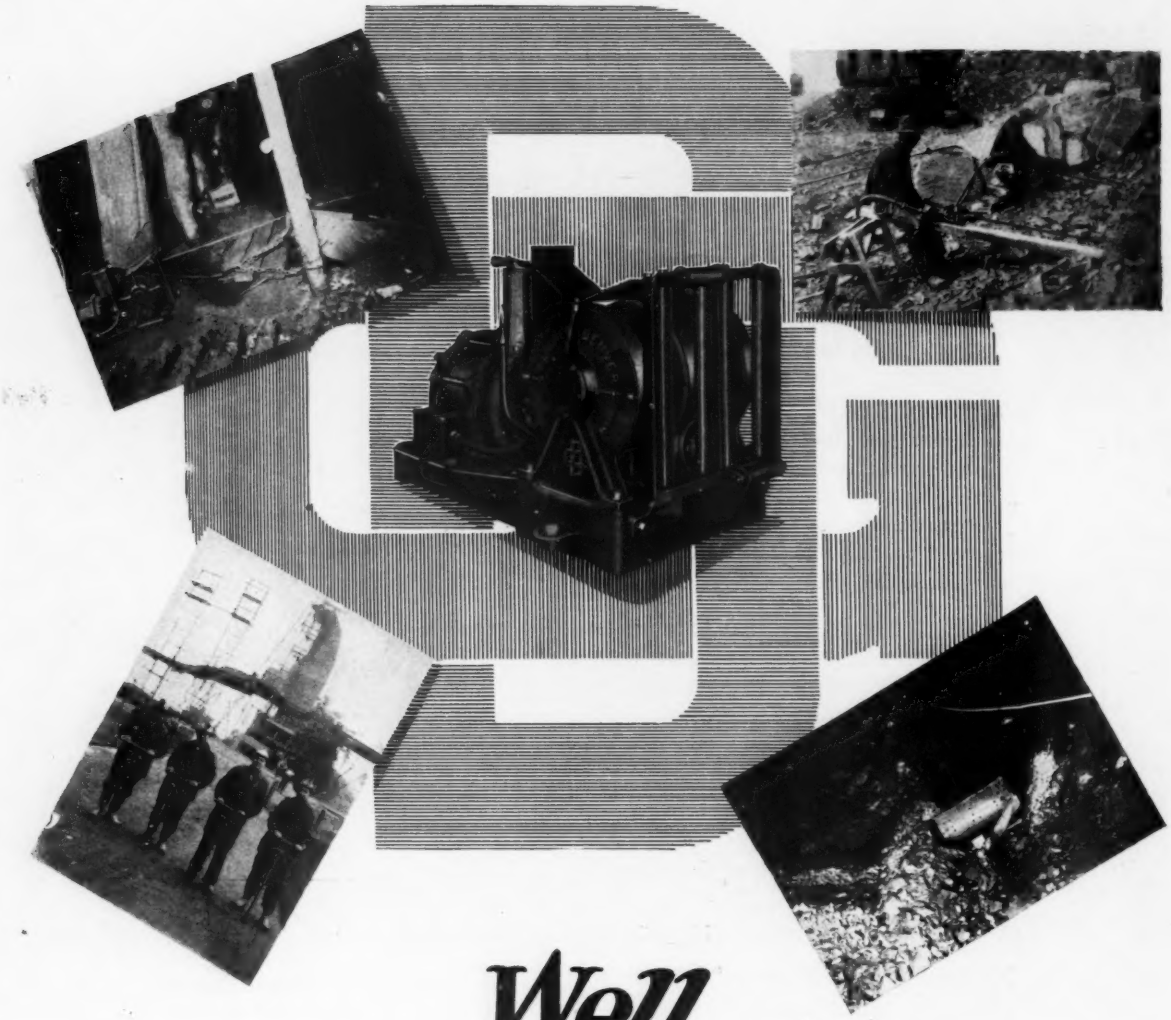
Locomotive Gathering Cables
Duracord* (Heavy duty portable cord)

Magnet Wire
Enameled, cotton covered
silk covered

*Trade-marks Reg. U. S. Pat. Off.

The high conductivity and uniform quality of Anaconda Metals are the result of the coordinated supervision by a single organization of every process from ore to finished product.

ANACONDA WIRE PRODUCTS



Well represented at Cleveland Cliffs

GARDNER-DENVER COMPANY
ROCK DRILL DIVISION
DENVER, COLORADO
Sales Offices Throughout the World

GARDNER-DENVER

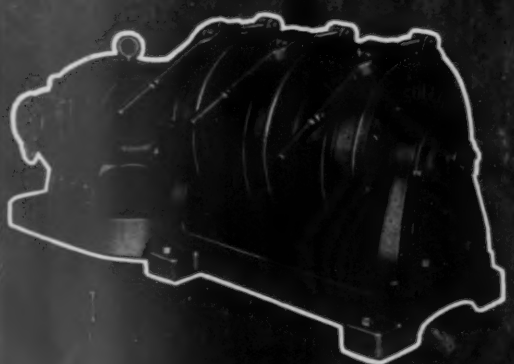
Cut Your Loading Costs with Sullivan Slushers

IRON MINING keeps its costs down by the wide use of Sullivan Scraper Loader Hoists. Sullivan Engineers have for years co-operated closely with Iron Mining engineers in developing portable hoists to suit the changing needs of ore-slushing work.

Sullivan Slusher Hoists have a reputation for low power-per ton cost, for small repair charges, for high tonnage records. (Records on request.)

Sullivan Slushers are built in 6½-7½ H. P. Turbinair and electric models; also in electric Super-slusher types of 10 to 75 H. P. The hoist shown in this picture is a 10 H. P. "HDE-4" double drum electric slusher, at the Sunday Lake Iron Co., Wakefield, Michigan.

Ask for the catalogs { *Air 37-76-F*, *Electric 37-76-G*, *Superslushers; 37-76-J*



Other Sullivan Iron Mining Equipment includes—
Diamond Core Drills
Rock Drills, all types
Drill Sharpeners
Air Compressors

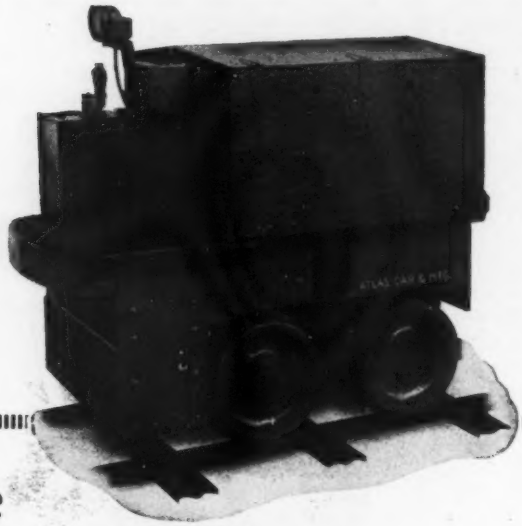
SULLIVAN Trade Mark

London Paris Mexico Santiago Sydney Tokyo Johannesburg Calcutta

SULLIVAN MACHINERY COMPANY
808 Wrigley Bldg., CHICAGO

Boston, Pittsburgh, New York, St. Louis, Cleveland, Knoxville, Birmingham, Dallas, Spokane, Duluth, El Paso, Denver, San Francisco, Salt Lake City.

Improved Low Cost Battery Locomotive



For Metal Mining Service

The Atlas Type J

1½ Ton Spur Gear Drive Locomotive

This locomotive unit effects new economies in metal mining haulage. Surprisingly low in first cost, yet reflecting performance of high order in lower maintenance costs and lower cost per ton of ore mined.

Study the specifications given below. Designed especially for metal mines, the Atlas Type J Locomotive incorporates features which assure the mobility and flexibility so desirable in mining service.

SPECIFICATIONS

Track Gauge	18 in. to 24 in.
Weight (chassis only)	2000 lbs.
Batteries	20 cells MVA 15 Ironclad 20 cells PML 17 Philco 40 cells A 5 Edison
Speed	2.5 to 6.5 MPH
Draw Bar Pull	400 lbs. @ 3.5 MPH
Length Over All	47 inches
Height Over Headlight	50 inches

LOWER FIRST COST PER UNIT
LOWER MAINTENANCE COST
LOWER COST PER TON

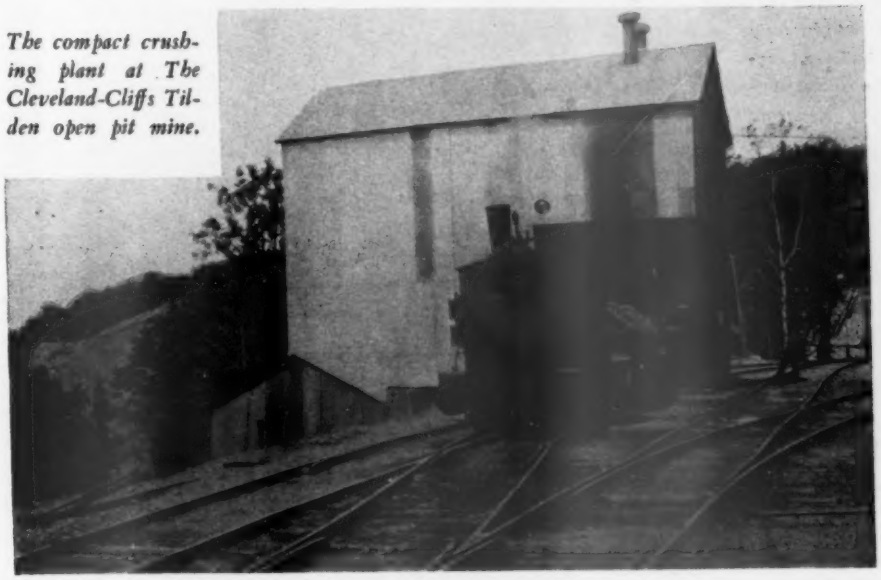
Let us quote prices on your next locomotive requirements

The Atlas Car & Manufacturing Co.

Engineers, Manufacturers

CLEVELAND, OHIO—U. S. A.

TRAYLOR Bulldog Gyratory at Cleveland-Cliffs



The compact crushing plant at The Cleveland-Cliffs Tilden open pit mine.

"* * * the cars from the pit dump directly into the hopper of a 42" Traylor Bulldog Gyratory Crusher set at 5½" opening * * *"

—From article in this issue entitled, "Tilden Open Pit Operation," by G. R. Jackson, G. S.

THE TRAYLOR AUTOMATIC FORCE-FEED LUBRICATION SYSTEM
AND
POSITIVE DUST SEALING DEVICE
(Both Patented)

—are two of nine exclusive features which influenced Cleveland-Cliffs to choose a Bulldog for the most important service in its crushing plant because the operator could take no chances regarding these two vital points, although, of course the facts that the Bulldog is overstrong in all parts and delivers large capacity at small cost per ton were not overlooked.

The reader is invited to send for our Bulletin 2100, descriptive of the Bulldog Gyratory, and while doing so, ask, also, for 2099, which treats of the Bulldog Jaw Crusher, the world's greatest jaw type breaker.

Wire, Phone or Write Our Office Nearest You

TRAYLOR ENGINEERING & MANUFACTURING CO.
ALLENTOWN, PENNSYLVANIA, U. S. A.

New York City 30 Church St. | Chicago 1414 Fisher Bldg. | Los Angeles 908-909 Chester Williams Bldg. | Seattle 815 Alaska Bldg. | Salt Lake City 101 W. 2nd So. St.

Export Department—104 Pearl Street, New York City

Foreign Sales Agencies: London, Rangoon, Sydney, Melbourne, Johannesburg, Lima, Rio de Janeiro, Sao Paulo, Buenos Aires, Santiago, Valparaiso, Antofagasta, Iquique, Ururo

European Works—Usines Carels Freres, Ghent, Belgium

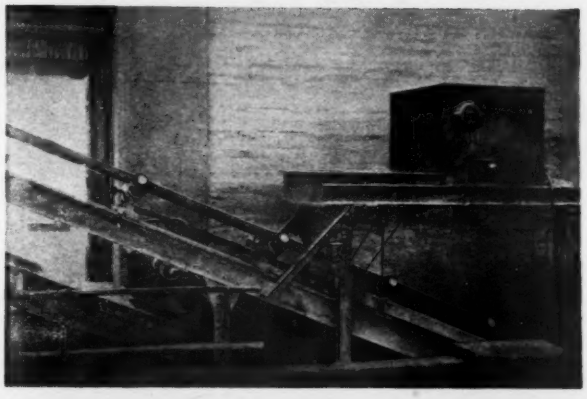
AT CLEVELAND-CLIFFS and many other mills the advantage of keeping an accurate check on tonnage handled is recognized as an important factor in the control of processes and costs.

There, MERRICK CONVEYOR WEIGHTOMETERS continuously and automatically indicate, register and record the actual tonnage handled on the conveyors without interruption of ore movement, during every hour of the day.

Wherever conveyors can be used to carry material, a Merrick Conveyor Weightometer will accurately weigh all passing material and mechanically register the weight.

MERRICK SCALE MFG. CO.
Passaic, N. J.

MERRICK

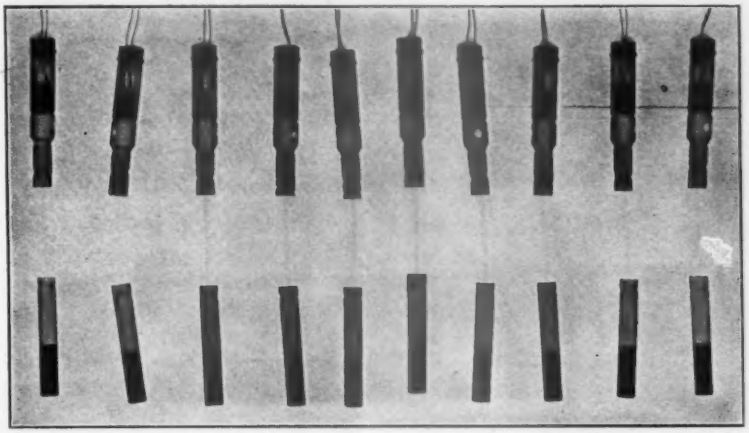


CONVEYOR WEIGHTOMETER

The UPSON-WALTON Co.
CLEVELAND
OHIO

Manila Rope
Wire Rope
Brattice Cloth
Tackle Blocks

Established 1871



This illustrates the use of X-ray photography in testing for uniformity in Hercules delay electric blasting caps. The X-ray reveals, from top to bottom of each delay electric blasting cap, the lead wires, firing head, delay fuse (in which only the powder train shows), and the blasting cap.

HERCULES DETONATORS ARE RELIABLE

THE reliability of Hercules detonators is equally important to us and to our customers. Many millions of pounds of explosives depend on the reliability of Hercules detonators for satisfactory performance, and for that reason we do everything possible to protect our customers.

That is why exhaustive attention was given to the basic design of Hercules blasting caps, electric blasting caps, and other Hercules firing devices, and why they are manufactured with painstaking care from materials selected and tested with equal vigilance. After all that is humanly possible has been done to control the manufacturing processes, the product is subjected to a series of elaborate and costly tests.

In making these tests, many branches of science are utilized. The X-ray looks through the copper shells to search out any flaw which previous to this scientific operation, could only be found by destroying the detonators. Microphotography is called upon to tell a significant story to the explosives chemist. All standard tests of recognized value as well as special tests devised in the Hercules laboratories are used to insure the reliability of Hercules detonators.

It is economy for you to purchase firing devices on which so much care is expended to insure success in your blasting.

HERCULES POWDER COMPANY

(INCORPORATED)

Wilmington Delaware

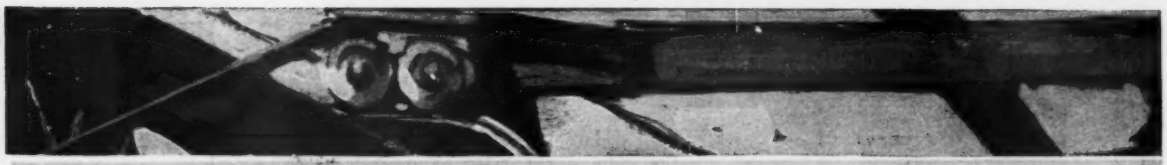
Sales Offices: Allentown, Pa., Birmingham, Buffalo, Chattanooga, Chicago, Denver, Duluth, Hazleton, Pa., Huntington, W. Va., Joplin, Mo., Los Angeles, New York City, Norristown, Pa., Pittsburg, Kan., Pittsburgh, Pa., Pottsville, Pa., St. Louis, Salt Lake City, San Francisco, Wilkes-Barre.

HERCULES POWDER COMPANY
934 King Street, Wilmington, Delaware

Gentlemen: Please send me the booklet HERCULES DETONATORS describing Hercules blasting caps, electric blasting caps, waterproof electric blasting caps, delay electric blasting caps, and delay electric igniters.

Name.....

Company..... Address..... 3272



The Phoenix Power Dump Car shown below is the type used by The Cleveland-Cliffs Iron Company. This car is supplied in smaller units in two other popular models—on four wheeled cars and on trucks for haulage in quarries from face to crusher. Car designed and patented by Easton Car and Construction Company.

EASTON CARS
FOR EVERY PIT, MINE AND QUARRY
Easton Car and Construction Company
Easton, Penna.

A DROP IN THE BEARING'S WORTH 10 IN THE BARREL..

Eureka Valves (a Hockensmith development) help your oil in its work of reducing friction, eliminating cutting, and lengthening the life of your wheels and axles. The valve has a full-babbited seat. It is sealed against dirt—yet is instantly opened, exposing a clean oil hole. When closed it locks positively, keeping sand, water, and other foreign matter out. Any kind of power or hand lubricating system can be used.

The picture tells the story—and also shows another Hockensmith contribution to the cause of efficient haulage—the new type disc-closure. On or off in a minute, it cannot be dislodged accidentally.

These are only two of many outstanding features available on Hockensmith cars. When you're in the market for mine car equipment —let Hockensmith quote.

EFFICIENT HAULAGE

HOCKENSMITH WHEEL & MINE CAR CO.

Penn, Pa. Long Distance Phone, Jeannette 700

SALES REPRESENTATIVES

Huntington, W. Va.—Huntington Supply & Equipment Co. **Knoxville, Tenn.—Webster & Co.**
Clarksburg, W. Va.—Mr. Norman Strugnell **Chicago, Ill.—W. W. Baker, 140 So. Dearborn St.**

90% Maintenance Cut with "Timken-Equipped"

—told by Mr. Jeffrey, General Superintendent of the Akron, N. Y., plants of the Universal Gypsum and Lime Co.—"With only 250 cars we have 249 or 250 of them in service all of the time and no bearing troubles . . . We grease twice a year and inspect them at the same time, although this is more of a precautionary measure as we have yet to find a dry bearing . . . *Our maintenance costs on cars have been reduced 90%* . . . forty cars per locomotive trip as compared to twenty before the cars were mounted on Timken Bearings."

All mining knowsthe economies of Timken Bearings—Timken thriftability to save power, save lubricant, save maintenance and save replacement for the greatest number of service years.

Only Timken Bearings can do this for only Timkens combine the radial-thrust advantages of Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken electric steel—wherever wheels and shafts turn.

THE TIMKEN ROLLER BEARING CO.
CANTON, OHIO

TIMKEN *Tapered Roller* **BEARINGS**

The MINING CONGRESS JOURNAL

**A Monthly Magazine—The Spokesman For The Mining Industry—
Published By The American Mining Congress**

VOLUME 15 | OCTOBER, 1929 | No. 10

Editorials

The Mine Depletion Report

THE Congressional Joint Committee on Internal Revenue Taxation now has before it a report on depletion allowances of the mining industry. This report is the result of more than two years' study by the committee's staff. It contains voluminous data and comparative statistics on mining income, dividends, and taxes. It alleges that the present system of depletion deductions is inequitable and in certain instances discriminatory. It proposes substitute plans for the consideration of the committee.

The mining industry will be unable to concur in many statements contained in this report concerning matters that may be considered fundamental. First, that depletion is a gift and not a right. Second, that the cost of the property is the proper basis for determining depletion. Third, that analytic valuations are subject to wide variations, involve speculative factors, and afford fertile ground for controversy, inequalities, and errors. Fourth, that one of the principal defects in the present system of income taxation is the lack of uniformity and certainty in computing depletion.

The report presents quite a serious indictment of the present system. Is it justified? In the first place, the legal concept of depletion has been well established ever since the sixteenth amendment was ratified in 1913. Neither the Congress nor the courts since have questioned the taxpayers' right to depletion based upon March 1, 1913, value, or upon cost if acquired subsequent to March 1, 1913. In the second place, the administrative system for the determination of mine values and the annual allowances from income due to the reduction of such values by mining has been fairly satisfactory.

The Bureau of Internal Revenue has valued all the mines of the United States, and many foreign mines owned by American interests, in a remarkably short space of time, and without any delays that have interrupted or even interfered with the collection of the income tax revenue. The Treasury has performed this gigantic task without complaint to Congress. And at the present time only exceptional cases, representing perhaps less than 5 percent of the total, remain open awaiting decisions of the Board of Tax Appeals or the courts.

There is a real need for some amendment that will correct certain inequalities that have been disclosed, and that are due mainly to circumstances and conditions prevailing at the basic date of valuation, such as the extent of mine development and the geology of the deposit to be valued; but not due to any weakness in the system of administration other than the limitations imposed by the law itself. Both the industry and the joint committee will have to look outside the report for the answer to the question as to what change from the present system is necessary or desirable.

We believe both the Treasury and the mining industry will be loath to abandon and scrap in its entirety a system that has been established and worked successfully from a revenue standpoint for so many years. No substitute plan would be acceptable unless it guarantees to both the Government and the mining industry the retention of the basic principles upon which the right to depletion rests as recognized now under the sixteenth amendment and the several income tax acts.

Rewriting the Tariff Bill

IT IS fairly evident that the tariff bill will be rewritten. The Senate Finance Committee will be unable to sustain their program because too many industries of the South and West who made pleas for increased protection were ignored, while the consumers of their products—the manufacturers—were successful in gaining recognition to the extent that increases were proposed on many manufactured products.

In the fight to be waged, the Senatorial forces will be aligned either with the non-metal mining and raw materials industries of the South and West, or the manufacturing industries of New England and the states bordering the Great Lakes. Against the antimony, clay, bauxite, barytes, graphite, mica, feldspar, gypsum, and other industries of the South, are pitted the chemical, paper, pottery, aluminum, lubricator, paint, electrical, and numerous other industries that use these raw materials, as well as the importers.

No sound reason appears for denying protection when representatives of an industry show the need for increased protection in the fact that importations are depriving them of their natural markets, which they would otherwise be able to supply from developed domestic reserves that are adequate for future domestic requirements.

In the case of practically all of the non-metallic mining industries of the South, seasonal employment is furnished to those engaged in agriculture, and their prosperity may be considered a condition precedent to prosperity in agriculture, since they provide local markets for perishable farm products as well as seasonal employment and pay rolls that are so necessary to the economic welfare of many local communities.

So that the Senators who, regardless of politics, are preparing to vote for the protection of industries in their states, are both politically and economically right. Permanent prosperity can not be insured to the country as a whole if a tariff bill is written that gives one industrial section protection at the expense of another. North, East, West, and South must have equal protection—raw materials as well as manufactures.

The Iron Ore Industry

THE iron ore industry has contributed immeasurably to our present-day civilization. It has been responsible in a large measure for the many advancements in industry. The services of iron—or steel—enter into the fabric of our every-day life. It has given us our transportation system, our modern skyscrapers, automobiles; in fact, enters into all modern machinery that has made our present economic life possible.

The discovery of the Lake Superior iron ore deposits has brought to us not only wealth, but a civilization unrivalled in history. The Cleveland-Cliffs Iron Company, whose story is told in this issue, is the oldest iron ore producer. It began its existence when ore was first discovered on the Marquette Range, and has been a steady producer since 1850, when the Cleveland Iron Mining Company was incorporated. Mr. Samuel L. Mather was president of this company and was succeeded by his son, Mr. William G. Mather, who is today president of The Cleveland-Cliffs Iron Company.

Under his leadership this company has come to stand for many of the fine things in industry. It is an inspiration to follow through from mine to market the operations of an organization that, while highly efficient and profitable, still is human. To W. G. Mather, and his group of able assistants, the good will of the industry and the country are due, for showing us what may be accomplished when a company adopts Safety as its Standard, Beauty as its Watchword, and Cooperation as its Spirit.

Efficiency—Plus

WHEN President Hoover visited the properties of The Cleveland-Cliffs Iron Company, he said that it was a real inspiration to find that so much beauty could be combined with so much efficiency. And that is literally true. Located in the heart of the lake country of northern Michigan, this property has the natural advantage of beauty, and every effort has been made to maintain it. There are no unsightly spots, and this is a real accomplishment when the nature of the deposits are taken into consideration. Flowers, shrubs, trees—landscaping features of all kinds—are given special attention and the result is most interesting.

Under the direction of Mr. Mather, and in cooperation with a most efficient and loyal group of executives, the company has attained an exceedingly high standard in its production methods, its industrial relations, and its cooperative efforts with outside agencies. Among their public-spirited projects are reforestation and cooperative effort with the national and state forestry services; the establishment of a natural game preserve; experimental farms; and a national park. For the employes, without a trace of paternalism, real opportunity is given for advancement. Schools, hospitals, clubs and supervised community life afford a cooperative service not found in our cities and larger communities.

Cleveland-Cliffs does not aspire to Utopia, but in a most practical sense represents industry at its best.

Our Export Trade

EVIDENCE of the soundness of this country's policy in relation to the world's commerce is found in recent figures compiled at the Department of Commerce. The United States closed the fiscal year 1929 with the highest export balance of merchandise trade for any year since 1922. Total exports for the fiscal year were 5,337,510,000 and total imports, 4,290,457,000, showing an export balance of 1,047,053,000. This is 317,053,000 higher than for the fiscal year 1928.

The prediction made some months ago, by those opposed to the Government's foreign trade policy during the last two administrations, that there would be a sharp falling off in this country's export trade as the result of that policy and the attitude in certain foreign countries toward the matter of war debt settlements, has failed to materialize in the slightest degree. On the contrary, our trade relations with foreign countries appear to be constantly improving. Our growing export trade balance also disproves the theory that in order to sell our products in foreign countries, we must allow the products of those countries to come in and freely compete with domestic products which can be adequately supplied by home industries.

This Government can not afford to abandon or even to modify a foreign trade policy that during the last eight years has proved such a boon to American industrial life and prosperity. With the growing consciousness in the minds of foreign peoples, that they are missing some of the greatest benefits of our modern civilization, especially in those European and Asiatic countries that have been backward in making use of modern methods, labor-saving devices, and electrical and mechanical appliances for the comfort and convenience of the people, such as are common to every section of this country, our export trade will continue to grow.

Mine Accidents

IN THE medical world an accurate diagnosis of any disease is the first step and usually leads to a complete cure in the hands of a skillful physician. To know the cause of a trouble is vastly important in bringing about its prevention. Whenever professional men express a conclusion concerning a matter in which they are equipped to express an opinion, we are bound to take notice. The insurance men frequently give theoretical opinions as to the cause of mine accidents. Mr. R. E. Simpson of the Travelers Insurance Company, in an address before the twentieth annual convention of the Mine Inspectors Institute of America, held at Knoxville, Tenn., makes the bald statement that 88 percent of all mine accidents may be charged to supervisory failures, 10 percent to physical failures and 2 percent to the class of unpreventable accidents. If this statement is true it would seem that our penitentiaries must be greatly enlarged to hold the mine operators who are entitled to admission.

As a matter of fact, the statement is unjustified, which Mr. Simpson practically admits in another part of this address. He says: "It is true in many a case, that the immediate cause is a dereliction on the part of the employe, but back of this there is generally a failure of the supervisory staff in giving instructions, enforcing discipline, selecting men for given duties, or planning processes and operations. Supervisory causes of accidents are probably more prominent in the coal mine industry than in other industries because infractions are hard to detect and, therefore, hard to check."

If the "immediate cause of an accident is a dereliction on the part of the employe," which is probably correct, then the blame should be upon him who violates orders and not upon the employer who, having given the order, can not follow the employe about to see that he does not violate the rule.

A similar statement was made by Dr. Frederick L. Hoffman of the Prudential Insurance Company at the San Francisco Convention of the American Mining Congress held in 1915, to which Mr. Harry L. Day, of

Wallace, Idaho, took exception and asserted that a long experience as a mine operator had convinced him that the greater number of accidents in mining operations was caused by the criminal negligence of the men who fail to obey orders.

The operator finds it very difficult to enforce discipline. He may discharge a man for breaking rules and employ in his place a man discharged by a neighboring mine for the same reason. There are few mine operators, if any, in this country who do not provide safety appliances, but lacking the power of enforcement of proper rules does not justify their being charged with the responsibility for the "natural indifference" of the employe.

Education and Safety

BUT whether or not the mine operator may be held directly responsible for the accidents at his property, he may be held distinctly responsible for failing to adopt and enforce strict safety rules, and to employ such supervisory force as to make his program effective.

At many of the mines violation of safety rules and regulations, for the first offense means reprimand; for the second, a lay-off and for the third infraction, discharge. In many instances the enforcement of these rules has been so effective that the workers themselves are the severest critics, and a considerable pride has been aroused in maintaining an enviable record.

The basis of all safety work is education. The personal equasion. All of the rules and demands ever promulgated will not solve the question, will not bring the right result. An efficient safety department with a supervisory head, with systematic and continual training along safety lines is absolutely essential if we are to reach the highest point in industrial safety. Secretary of Labor James J. Davis, in a recent radio address, in commenting upon the record of accidents in this country said:

"Universal safety is the ideal of our industrial future. It is an ideal of as much worth to the employer as it is to the employe. It means more than the mere reduction of insurance premiums and a 'cut rate' funeral. It means a stronger, more rugged and happier, healthier nation of workers. Medical science is daily successfully combating disease and thereby prolonging life; but the kind of medicine that will reduce industrial accidents is not found in the kit of any practicing physician. It is found in all true minds and hearts—minds and hearts which are willing to sacrifice some speed and rapidly acquired wealth for safety and comfort for the working men and women. The employer today who is unwilling to invoke every ounce of caution in behalf of his workers is not worthy of the American mark of civilization; and the employe who is not mindful of the work safety of his fellow workers is a menace to the very society which gives him protection from every other ill which might beset his life while away from his job.

"Safety means better working conditions; it means steady jobs and better pay. Plants that operate with the greatest efficiency are those in which working conditions are stable and permanent. Hazards interfere not only with life and limb but with prosperity as well. The prosperous plant is the safe plant. The prosperous worker is the safe worker."

In the mining industry real effort is being made to reach the highest possible safety record. We have the National Safety Competition, safety meets in every section of the industry, and a large number of companies have well-planned safety campaigns as a part of their daily work. In addition practically every mining organization from the Bureau of Mines down to the local associations carry on continuous campaigns in behalf of safety. There is much to be done, but the most important fact is that all wheels are turning coordinatedly in the right direction.

The Public Lands

PRESIDENT HOOVER, in a letter to Assistant Secretary of the Interior Joseph M. Dixon, presented to a conference of Western Governors, at Salt Lake City August 26, a proposal for a thorough investigation of the public lands problem.

His proposal includes the appointment of a commission of nine at least, five of whom are to be selected from the Western States, to make a complete survey, in order that "We should determine the facts in the present situation, should consider the policies now being pursued, and the changes which I might recommend to Congress."

Mr. Hoover continues—

"These suggestions are, of course, tentative, pending investigation of the full facts, but, generally, I may state that it is my desire to work out more constructive policies for conservation in our grazing lands, our water storage, and our mineral resources, at the same time *check the growth of Federal bureaucracy, reduce Federal interference in affairs of essentially local interest, and thereby increase the opportunity of all states to govern themselves and in all obtain better government.*"

What more assuring words could be crowded into one sentence, looking to the settlement of our public lands problems, which have been under acute discussion so many years: "More constructive conservation of all resources," "Check the growth of Federal bureaucracy," "Reduce Federal interference in affairs of essentially local interest," "Increase the opportunity of all states to govern themselves," and "to obtain better government."

These are the principles which have been contended for by western speakers for more than 20 years. We venture the assertion that, when the proposed commission has made its recommendations, few will be found to criticize the report.

We do not believe that any plan could be proposed, better adapted to work out a fair solution of the long-standing controversies regarding public lands, nor more likely to educate the East to a proper conception of these problems, and thus secure congressional approval of the recommendations made.

The reception given this proposal by the West has not been cordial. While objections have been based on wholly contradictory premises, no one has been found with sufficient affrontery to object to the investigation of a recognized public problem by a commission, the control of which is to be vested in men from the western public-land states.

We must not lose sight of the fact that the control of public lands was one of the corner-stone principles of the so-called conservation program, nor that the defenders of that destructive program are now exercised in criticism of Mr. Hoover's proposal.

The West should appreciate that no other President will ever again have the courage to draw the fire of eastern criticism, for the sake of a section which fails to recognize the first helping hand offered by any President for 25 years.

A National Necessity

WE EXPECT five or ten million people to starve each year in China, but thirty million is too much."

This statement, said to have been made by a Chinese leader, sounds a startling note of warning to the younger

nations of the world, and particularly those who are careless in meeting by all possible means the national necessity to prevent soil erosion.

The Chinese people are frugal and industrious. They live well on less than the waste from the tables of a similar number of Americans. The denudation of her forests centuries ago, and the necessarily consequent soil erosion, has made it impossible for her, even with the most intense cultivation, to produce enough food to sustain the lives of her peoples.

Each year the forested areas of the United States suffer enormous losses by fire. Seemingly these losses are increasing in destructiveness. The current year's losses of lumber in the great Northwest—Montana, Idaho, Oregon, California and Washington—are estimated from thirty to fifty millions of dollars, and this is the smallest part of the loss. The loss by soil erosion, continually augmented by forest destruction, can not be estimated in money, and is a growing menace to our future civilization.

Notwithstanding the enormous fire losses, it is believed by many well-informed men, particularly in California, that the destruction of timber by the pine beetle in that state is greater than the fire loss. It is also believed by many that the system of the United States Forestry Service, in its efforts to preserve the forests, is fundamentally wrong. That its prevention of fire augments and protects the breeding nests of the *Pine Beetle* and other insect tree enemies and, at the same time, accumulates the combustible material in the forests, so that, when fire does come, as it seems always to come, the heat is so great from the burning up of this stored-up material as to kill the growing timber.

Possibly our scientific forester might, with great profit to the country, take a lesson from Poor Lo, who bequeathed to us the magnificent forests, the rapid destruction of which we are permitting.

Our uneducated but wise predecessors in forest control, the Indians, each year before the dry season burned over the forest areas, thus destroying the larvae of the tree enemy insects, and thus prevented the accumulation of inflammable material which, if burned during the dry season, entirely destroyed the surrounding tree life.

Perhaps the appropriations for the Forestry Service are not sufficient to enable it to properly meet this responsibility. Perhaps the system of forest protection needs revision. In either case, a radical change should be made to meet this intensified national necessity.

Forest Responsibility

NO ONE will question the importance of a better and more effective handling of national forest problems as outlined in the preceding editorial.

It is somewhat strange that there are some who propose that this responsibility shall be assumed by the Western States, probably because of an impression that the forests have an earning power in excess of operating costs.

President Hoover has voluntarily offered to appoint a commission to study the public lands situation and recommend to Congress such legislation as would best serve western development, with the contemplated purpose of ceding to the several states the surface rights in the public domain. Both the East and the West have criticized this proposal, but for diametrically opposing reasons. Some leaders of western thought insist that, "If the Federal Government is to retain the forests and all the minerals it would simply be unloading a white elephant upon the states."

Mr. Hoover does not propose a transfer of the national forests.

During the fiscal year ending June 30, 1928, the entire receipts from the national forests (including timber sales, grazing fees, water power and trespass penalties) were $5,441,434; during the same period the costs of administration (including $4,000,000 from the Bureau of Public Roads, expended for roads in the forests) were $21,732,480, leaving a deficit of $16,291,046.

It is difficult to understand why any state should wish to assume its share of that enormous deficit, particularly in view of the fact that, even with this deficit, an enormous loss, estimated to average twenty million dollars annually in timber and a loss from soil erosion many times greater, has been suffered during the present year. Plainly, a much larger deficit would have been justified if these irreparable losses could have been prevented.

It is equally clear that forest protection, water supply and soil erosion are national, not state problems. This burden must be carried by the Federal Government. It is a perfectly just Federal expenditure.

The Rocky Mountain States get little, if any, benefit from the improvement of rivers and the construction of harbors. These states are plainly disadvantaged by the construction of the Panama Canal, to the costs of which they contributed.

The maintenance of national parks and forests and the construction of public roads are among the expenses of the Federal Government, which, in part, recompense those states for their contribution to other public works from which they derive little or no advantage.

The West does not want the control of nor the responsibility for the national forests.

Merited Praise

"A PROPHET is not without honor, save in his own country" is a proverb that has been proven many times. Frequently we are so close to those who serve us that we do not appreciate the value of the service. At any rate, our neighbors to the north pay a glowing tribute to the work of the industry's chief representative in the Federal Government, the United States Bureau of Mines. *The Canadian Mining Journal*, in a recent editorial, says:

"The United States have every reason to be proud of their Federal Bureau of Mines. There is hardly a mail that does not bring us some evidence of the tremendous amount of investigative work being carried out by this department in every phase of mining and metallurgical science. The amount and scope of the work carried out by the various officers of the Bureau is very large and deserves more recognition than appears to be given through the technical press of the world.

"A more vital point is, however, the generous way in which the results of investigations are given to all countries, and we would like to set on record our appreciation of the great work being carried out by the United States Bureau of Mines in the advancement of mining science. A great deal has been written and said of all we owe to American enterprise and capital, and without in any way detracting from our recognition of what we owe in this direction, we can not help saying that we owe just as much to the quiet work of the engineers and scientists of the American Bureau of Mines."

The mining industry has many reasons to be proud of the Bureau of Mines. The service it has rendered the industry is of vast importance in solving many of its greatest problems. It would pay the individual operator, and the industry as a whole, to become more intimately acquainted with just what the Bureau is equipped to give.

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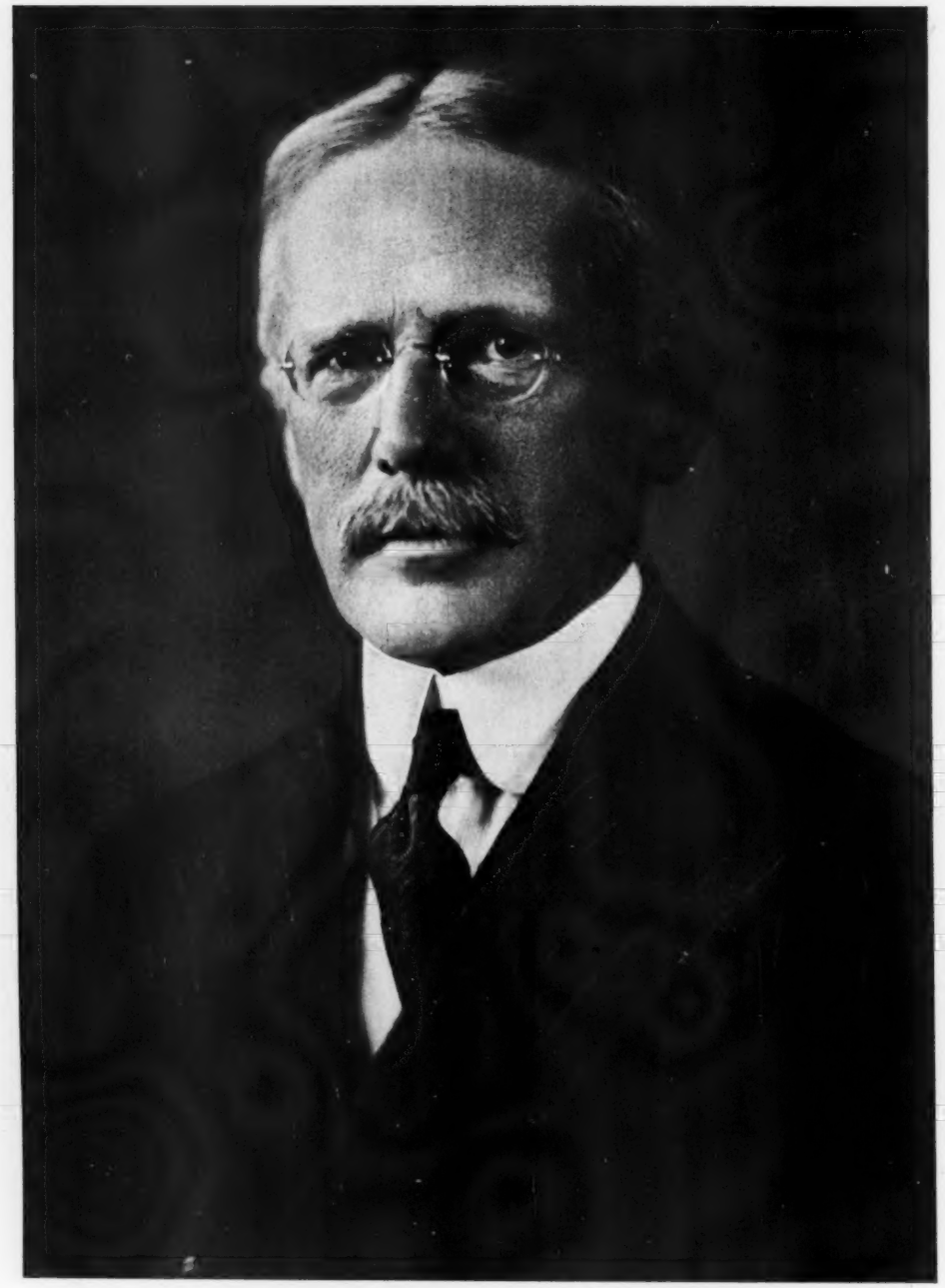


WILLIAM G. MATHER

President of The Cleveland-Cliffs Iron Company

The IRON INDUSTRY of the Lake Superior Region

By WILLIAM G. MATHER *

Present age that of steel, with entire civilization dependent upon it—Iron greatest single factor in construction of fabric of modern life—Future of industry may be even greater than past—Beneficiation processes, methods of locating ore bodies, among factors controlling future iron supply

FOUR groups of events led to the establishment and the prosperity of the people of the United States. These were, first, the discoveries of this continent and the colonization of the northern part. Second, the unification of the colonies in the War of Independence. Third, the establishment of Federal supremacy in the War of the Union. Fourth, the discovery of the Lake Superior iron ore deposits and the consequent development of the iron industry.

The discovery of the Lake Superior iron ore has contributed more to the wealth and well-being of this Nation than has been gained from all the gold of California and Alaska.

The services of iron—that is of steel as we use it—has been and is the greatest single factor in the construction of the fabric of the modern life of this country. The use of steel implements has made farmers prosperous and developed agriculture into a preeminent industry. Steel has made modern transportation. It has laid railroads with giant cars facilitating the rapid transportation of freight in large quantities; and with excellently appointed trains has made luxurious travel and communication the common experience of every man. It has made the automobile possible, with all the attendant developments in hundreds of contributive and resultant lines of business, manufacture and improved roadways. Steel has made marine transportation what it is; it has bridged the Lakes and seas with dependable highways. Our cities are clusters of steel structures. Steel enters into all machinery, and into equipment for national defense, into tools for industry, and instruments of every kind for science and surgery.

The present age is, of course, that of steel and our entire civilization is dependent upon it. But what has distinguished the United States and given to it its great advantage is that bestowal by bounteous nature upon this land of those deposits of iron ore in such vast quantities in the Lake Superior region—the largest known and operated in the world. It has made possible and directly encouraged that large quantity production which has rapidly developed within the steel industry, and which as it grew spread into other lines and also furnished them with machinery to facilitate mass production in those lines. It is this mass production in many fields which has given to our country the industrial leadership which it enjoys.

S. L. MATHER

Vice President of The Cleveland-Cliffs Iron Company

The Cleveland-Cliffs Iron Company and its predecessor companies, going back to the opening of the earliest-found deposits—those on the Marquette range, where ore was discovered in 1845—has performed its share in the expansion of the iron ore industry of the Lake Superior region.

By 1855 ore dug with picks and shovels was hauled over a plank road to the water's edge at Marquette to be carried to lower Lake ports in small sailing ships built of wood. It was in that year that the Cleveland Iron Mining Company—of which my father, Samuel L. Mather, was one of the incorporators and later its president—mined and transported through the newly opened ship canal around the rapids at Sault Ste. Marie and carried down to Lake Erie the first cargo of Lake Superior iron ore. The ship was the brigantine *Columbia* and it carried 132 tons of ore.

For a long time the unloading was by means of a shovel-filled barrel hoisted by rope over a pulley, drawn by a mule. Furnaces were of small capacity and uncertain in action. The hauling of Lake Superior ore to markets in Ohio and Pennsylvania was

*President, The Cleveland-Cliffs Iron Company.

costly. Demand was poor and prices were low in relation to costs. Eastern ore had the advantage of shorter hauls.

In the year 1878, when I entered the office of The Cleveland Iron Mining Company as a clerk, the Marquette range was practically the sole source of ore shipped from the Lake Superior region. The mines in the Marquette range in that year shipped 1,039,368 tons of ore.

In spite of the difficulties, physical and financial, which beset the steel industry, other iron ore ranges were developed into producers soon after they were discovered. In 1879 the Menominee range sent out 247,135 tons of ore. In 1885 the Gogebic and Vermilion ranges added their contribution to the rapidly increasing output. In the early nineties the Mesabi range began to disgorge its mammoth yield. In 1911 the Cuyuna range commenced to produce. In 1916 the total yield from all the ranges in the Lake Superior region was 66,672,359 tons of ore, which is the largest annual shipment to date. The Cleveland-Cliffs Iron Company now controls properties on the Marquette, the Menominee, the Mesabi, and the Cuyuna ranges.

Engineering ingenuity has from the early days supplied constantly improved methods for extracting, treating, and transporting this ore as the tonnage output increased. The underground mines of the old ranges have offered their own difficulties in extraction. While the Mesabi range ores, which can generally be removed in open-pit mines by steam shovels, have offered difficulties in stripping off the overburden and in the beneficiation of the lower grade ores.

Improvements which have been made in every process and detail of the iron ore industry might be typified by one or two. The pick and shovel of the early days in underground mining has given place to the use of high explosives, mechanical scrapers and hoists. The small machine used in the first open-pit mining has yielded to steam or electric shovels of 400 tons weight, each equipped with a 6 or 8 yd. dipper, which will dig a cut 128 ft. wide at the level of the shovel track and lift the material 60 ft. above the track. In the process of stripping electrically driven drag line excavators are used which excavate 40 ft. or more below the track on which they stand.

Wheelbarrows, by which it took weeks to load even the small vessels of the pioneer days, have yielded place to concrete and steel ore docks with facilities which have loaded 200 tons per minute, record time, and which commonly load 12,000 to 13,000 tons of ore in four hours.

The picturesque unloading equipment at the receiving docks of the Lake Erie ports in the early days, with the barrel and mule, has given place to modern unloaders with self-filling buckets which take up 15 tons at each grab. A dock with four such machines can unload 50,000 tons per 24-hour day.

The small sailing ships of wood which carried not more than 1,100 tons of cargo have disappeared from the Lakes as completely as the ships of Commodore Perry. The steel freighter of today carries over 13,000 tons in a single cargo.

The Federal Government has spent wisely enormous sums on the locks at Sault Ste. Marie, and on the dredging, deepening, charting and marking of channels, so that the loading draught of steamers has increased from 12 to 21 ft.

Much remains to be done by the engineers of the future. The known reserves of merchantable ore are still enormous, but they are limited. Suitable and practicable means of beneficiation of existing and known great bodies of ore of too low grade for present use in the furnaces are being devised. Means may yet be found by which ore at depths beyond excavation by our present methods may be brought into use. Improvements may be made in the methods of finding bodies of ore not at present known. Great as is the present status of the iron ore industry in the Lake Superior region, its future may even be greater.

The presidents of The Cleveland-Cliffs Iron Company and its predecessor, The Cleveland Iron Mining Company, with the dates they were elected, have been as follows:

M. L. Hewett, February 10, 1851.
Selah Chamberlain, March 17, 1855.
W. J. Gordon, February 23, 1856.
George Worthington, June 1, 1866.
Samuel L. Mather, May 18, 1869.
William G. Mather, May 27, 1891.

The present organization of The Cleveland-Cliffs Iron Company is as follows:

Executive Department

Wm. G. Mather, *President, Cleveland, Ohio.*

S. L. Mather, *Vice President, Cleveland, Ohio.*

C. G. Heer, *Treasurer, Cleveland, Ohio.*

V. P. Geffine, *Secretary, Cleveland, Ohio.*

E. H. Jaynes, *Assistant Secretary, Cleveland, Ohio.*

Other Department Heads

Ore Sales, H. A. Raymond, *Cleveland, Ohio.*

Marine, A. E. R. Schneider, *Cleveland, Ohio.*

Pig Iron, D. T. Croxton, *Cleveland, Ohio.*

Chemical, C. B. Hall, *Cleveland, Ohio.*

Coal, A. D. Carlton, *Cleveland, Ohio.*

Mining, S. R. Elliott, *Ishpeming, Mich.*

Railroad, H. R. Harris, *Marquette, Mich.*

Land, J. M. Bush, *Negaunee, Mich.*

Furnace, E. J. Hudson, *Marquette, Mich.*

Lumbering, F. W. Hyde, *Marquette, Mich.*

General Office (left) and Engineering Office (right) of The Cleveland-Cliffs Iron Company, at Ishpeming, Mich.

The Cleveland-Cliffs Iron Company

HISTORY and ORGANIZATION

By S. R. ELLIOTT *

Company organized in 1850 and shipped its first ore in 1852—The history of the growth and development of one of the iron industry's most interesting producers outlined

THE beginning of what is now The Cleveland-Cliffs Iron Company dates back to the year 1850, when the first move looking to the possible formation of an iron mining company was made by a few men who organized for the purpose of acquiring lands in the Lake Superior district. A special charter was granted in 1851 to The Cleveland Iron Mining Company and articles of incorporation were filed in 1853, signed by Samuel L. Mather, Morgan L. Hewett, Selah Chamberlain, John Outhwait, Isaac L. Hewett, E. M. Clark, and Henry F. Brayton. The capital was $500,000, with 20,000 shares of stock having a par value of $25 each.

In 1852 about six barrels of iron ore were shipped to Cleveland, Ohio. A plank road was the first means of transporting the ore from what is now Ishpeming to Marquette, and the construction of this 16 miles of road required about three years to complete.

The first ore found at the Cleveland mine was at the base of Jasper Knob, Ishpeming, being "float" which had broken from ledges and carried in the valley in glacial times. These large boulders of ore furnished the product of the mining operations for some months; and even though necessary to sledge them into sizes convenient for handling into the wagons, they were more easily handled than the ore in the ledges. The ore was all of the hard variety; the softer red hematite not being known at that time or, if it was, the explorers of that period considered it to be of no value. Mining, or quarrying, was a tedious operation, and was all done with hammers and picks. It was long before the discovery of dynamite and black powder was exceedingly hard to get.

S. R. ELLIOTT

In 1854 the output of the mines was 4,000 tons. During that year 1,000 tons was transported from Marquette by boat. A few small vessels were dragged over the portage, but all the ore had to be reshipped at this point. The Sault Ste. Marie Canal was opened in 1857 and The Cleveland Iron Mining Company shipped the first cargo of iron ore through the lock in the brigantine *Columbia*. The first railway connecting the mines to the port of Marquette was the Iron Mountain Railway built in 1857. In 1864 the Chicago & North Western Railway built a line from Escanaba to Negaunee, which provided an outlet for Marquette range ores to Lake Michigan.

In the year 1878 the shipments of iron ore from the Lake Superior region totaled 1,110,100 tons, of which 142,815 tons were produced by The Cleveland Iron Mining Company. It is interesting to compare this tonnage with the year 1928, when the total shipments were 54,855,641 tons. In the war year 1916 the shipments totaled 66,903,300 tons.

The year of the panic, 1873, and the next years following were depressing for the mine operators. In 1879, however, business improved, and the sales of iron ore in small quantities were made in Cleveland at $15 a ton. In 1880 the total estimated output was sold at $12 a ton for standard Cleveland iron ore, averaging 65 to 66 percent iron.

The old wooden ore dock, the first erected at Marquette

* Manager, Mining Department, The Cleveland-Cliffs Iron Company, Ishpeming, Mich.

Harbor, was sold in 1882 to the Marquette & Western Railroad, the predecessor of the Iron Mountain Railway. By this time there was no doubt that the iron ore business had come to stay, and the extent of the ore deposits had become much better known. More substantial and convenient buildings became necessary at the mines; therefore in 1882 the brownstone machine shops and engine house at Ishpeming were constructed. These were the forerunners of all substantial mine buildings which have been erected up to the present time. The buildings are still being used though not for their original purpose. The Cleveland-Cliffs Iron Company (which succeeded The Cleveland Iron Mining Company by a consolidation with the Iron Cliffs Company) has always been noted for the manner in which it keeps up its mine buildings, dwelling houses and gardens. For many years the president of the company has given prizes for the best kept premises and best gardens. These competitions have done much toward beautifying miners' homes and their surroundings.

View, taken in 1860, of No. 1 Pit of Jackson Mine, Negaunee, Mich.

In 1888-89 the building of the steamers *Pontiac* and *Frontenac* laid the foundation for the fine fleet of steel vessels now owned by the company. These vessels were the first steel iron ore carriers to be built by a mining company. The boats were designed for carrying ore on a 15½-ft. draft, which was then the limiting depth of water in the connecting rivers. Twenty-seven hundred tons was the capacity of the *Pontiac*, while that of the *Frontenac* was 2,500 tons, the former being 320 ft. by 40-ft. beam and the latter 289 ft. by 39-ft. beam. An interesting illustration of the progress in late shipbuilding is afforded by the latest steamer built for The Cleveland-Cliffs Iron Company, the *Wm. G. Mather*. It is 614 ft. long with 62-ft. beam, and has a carrying capacity of slightly over 13,000 tons on a 21-ft. draft. This last acquisition brings the total number of steel vessels owned by the company to 12. In addition, there are 10 boats operated by the company, making a total of 22 in the operated fleet.

Monument erected on the site of the Carp Forge, Negaunee, Mich. First forge erected in the Lake Superior region (1847) to smelt iron ore

Monument erected at the North Jackson Mine, Negaunee, Mich., marking the spot where iron ore was first discovered in the Lake Superior region in 1845

Monument erected in 1900 to commemorate the fiftieth anniversary of the founding of The Cleveland-Cliffs Iron Company

The control of the Iron-Cliffs Company, of which Samuel L. Tilden and William B. Ogden were the leading stockholders, was brought about in 1889 and 1890. This purchase, covering a great acreage in mineral lands in fee besides several valuable mines in operation, gave a strong impulse to the acquisition of still more mineral properties in fee as well as through lease, and it is claimed by competent geologists that The Cleveland-Cliffs Iron Company is now preeminent in the extent of its fee ore reserves among all the operating companies in the Lake Superior region.

The acquisition of the control of the Iron Cliffs Company brought with it the Pioneer charcoal blast furnace, built in 1857 at Negaunee, together with a considerable acreage of timberland from which wood for charcoal was obtained.

The manufacture of charcoal iron, as inherited from the Iron Cliffs Company, was continued and further developed by the building in 1896 at Gladstone of a modern plant for the saving of by-products. In 1903 a still finer plant, the Pioneer furnace, was constructed, and is now being operated at Marquette.

The year 1895 marks the company's entrance into railroad construction, and in conjunction with the Pittsburgh and Lake Angeline Iron Company it built the Lake Superior & Ishpeming Railway.

This railway company now operates 160 miles of main line, 143 miles of other tracks, has 1,779 cars, 34 locomotives, and a steel and concrete ore dock.

The Munising Company's property was acquired in 1900. This purchase comprised the Munising Railroad, about 80,000 acres of land, and Grand Island (renowned for its beauty) near the town of Munising. In the following year the Marquette & Southeastern Railroad, connecting Munising with Marquette, was completed.

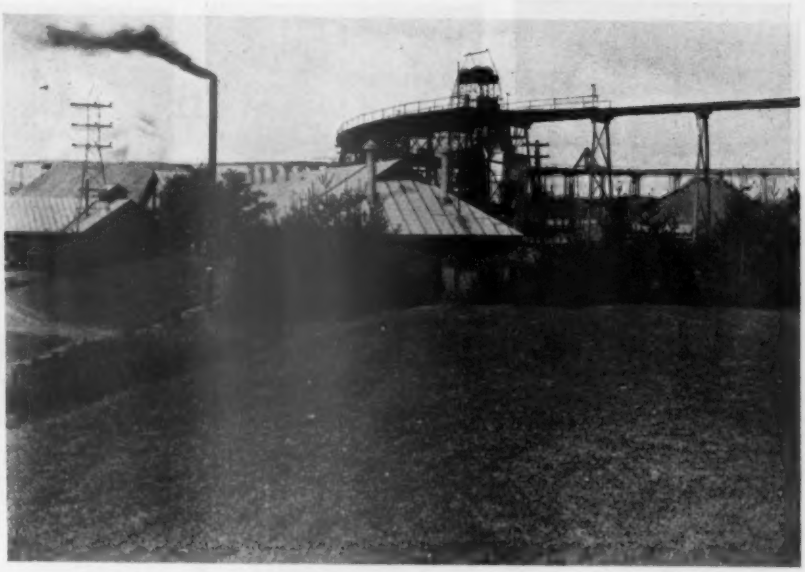
The acquisition of additional mines was begun in 1902, when the Maas property in the city of Negaunee was taken in lease. In 1904 the Negaunee mine was leased and operated by The Cleveland-Cliffs Iron Company, although owned jointly by them and the Bethlehem Steel Company. The following year the rounding out of our properties into a solid group of fee mineral lands was further carried forward by the purchase of the Jackson Iron Company, founded in 1845.

A drilling campaign was started in 1902 in what is known as the Gwinn district. Previous to this time the Princeton and Stegmiller mines had been operated, but no extension of these ore bodies had been found. The company first discovered the Austin mine and later the Stephenson, Francis, Gwinn and Gardner-Mackinaw; and in 1905 the Princeton mine was purchased. Since then the ore in the Austin, Stephenson and Françis has been exhausted and the Gwinn mine lease relinquished, the Gardner-Mackinaw and Princeton being the only properties now owned by the company in this group.

In 1905 ore was discovered by diamond drilling in what is known as the Athens mine at Negaunee. This property is jointly owned by Pickands, Mather & Company and The Cleveland-Cliffs Iron Company, but operated by the latter. The first ore from this property was produced in 1918. In 1907, in what is now known as the North Lake district, ore was discovered on section 3, township 47 north, range 28 west. Shortly after this work was started on the sinking of three shafts, and a large property known as the Morris-Lloyd mines were developed.

Hydroelectric power was first developed on the Au Train River in 1910 and in 1911 on the Carp River. Five years later, in 1916, the development of the Dead River was begun. These hydoelectric plants are operated under the name of The Cliffs Power and Light Company and supply current for the operation of all of our mines.

The company in 1924 acquired the Republic mine, a hard ore property, which had been working since 1870; operation was continued up to the exhaustion of the available ore in 1928.



Morris-Lloyd Mine, Ishpeming, Mich.

Holmes Mine, Ishpeming, Mich.

Some few years earlier, in 1902, the company acquired the Crosby mine, its first property on the Mesaba range. Before the mine was opened up it was thought that all of the ore was of direct shipping grade. However, it later developed that it was practically all wash-ore and a washing plant was constructed and the mine worked until the surrender of the lease in 1922.

In 1919 the Mesaba-Cliffs Mining Company was organized. The properties controlled by this company were the Boeing, Hill-Trumbull, Bingham and the North Star. The Boeing was a combined underground and open-pit operation and was operated until 1927, when the lease was surrendered. The Hill-Trumbull mine supplies a high grade of wash-ore and has been a steady producer.

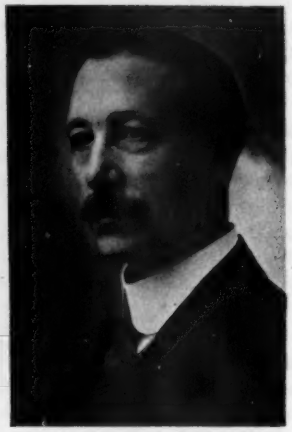
In 1926 the Holman-Cliffs Mining Company was formed to operate what was formerly the Holman-Brown property. This is another wash ore property, and will go into operation in conjunction with the Bingham and North Star properties in the season of 1930.

In 1929 the Canisteo-Cliffs Mining Company was organized to operate the old Canisteo property. Construction will be started on a concentrating plant this year and ore will probably be first produced in 1931.

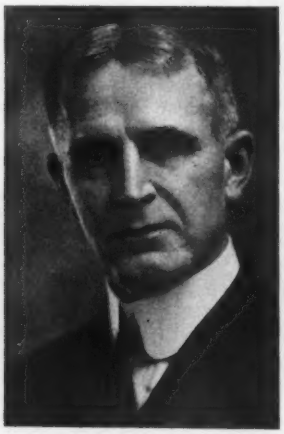
C. J. STAKEL
Supt., Morris-Lloyd Mine
Ishpeming, Mich.

A. J. YUNGBLUTH
Purchasing Agent
Ishpeming, Mich.

J. E. JOPLING
Consulting Engineer
Marquette, Mich.

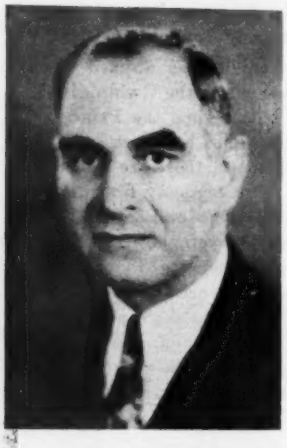


C. J. SHADDICK
Asst. Auditor, Mining Dept.
Ishpeming, Mich.



O. D. McCLURE
Chief Mechanical Engineer
Ishpeming, Mich.

J. S. MENNIE
Master Carpenter
Ishpeming, Mich.



W. R. MEYERS
Chief Mining Engineer
Ishpeming, Mich.

The present organization of the mining department of The Cleveland-Cliffs Iron Company is as follows:

S. R. ELLIOTT, *Manager, Ishpeming, Mich.*

G. R. JACKSON, *General Superintendent, Ishpeming, Mich.*

O. D. MCCLURE, *Chief Mechanical Engineer, Ishpeming, Mich.*

A. J. YUNGBLUTH, *Purchasing Agent, Ishpeming, Mich.*

W. W. GRAFF, *Superintendent, Negaunee and Gwinn districts, Negaunee, Mich.*

LUCIEN EATON, *Superintendent, Ishpeming district, Ishpeming, Mich.*

M. H. BARBER, *District Superintendent, Hibbing, Minn.*

C. J. STAKEL, *Superintendent, North Lake district, Ishpeming, Mich.*

J. E. JOPLING, *Consulting Mining Engineer, Marquette, Mich.*

W. R. MEYERS, *Chief Mining Engineer and Superintendent, Spies Virgil, Ishpeming, Mich.*

E. L. DERBY, *Geologist, Ishpeming, Mich.*

H. C. BOLTHOUSE, *Superintendent, Hill-Trumbull and Holman-Cliffs mines, Marble, Minn.*

CARL BREWER, *Assistant Superintendent, Negaunee district, Negaunee, Mich.*

WM. CONIBEAR, *Safety Inspector, Ishpeming, Mich.*

J. S. MENNIE, *Master Carpenter, Ishpeming, Mich.*

C. J. SHADDICK, *Assistant Auditor, Ishpeming, Mich.*

W. H. MOULTON, *Secretary, Pension Department, Ishpeming, Mich.*

The facts in connection with the historical part of this article were taken largely from an address given by Mr. Wm. G. Mather at a dinner in Ishpeming on September 24, 1928, in commemoration of his 50 years of service with The Cleveland-Cliffs Iron Company. Other historical facts are from an article in the *Iron Ore*, dated July 14, 1900, written by the late Mr. George Newett, Sr., at the time of the semi-centennial of the company.

GEOLOGY of Ores on the Marquette Range

By E. L. DERBY, JR.*

Age and general structure of the iron formation—Geology of ore occurrence—The Diorites—Thickness and depth of oxidation—Hard and soft ores

AS THE mines of The Cleveland-Cliffs Iron Company on the Marquette Range are scattered quite broadly over the productive portion of the Range, their geology involves practically all of the geological features of the Range as a whole, so that a notation of the principal ones will, I trust, give some conception of the occurrence of ore in the several mines of the company and the structural conditions that control it.

Certain broad conditions under which the workable bodies of iron ore on the Marquette Range occur are well recognized by both geologists and practical men. They may be stated in general terms as follows:

(1) The ore bodies occur within or adjacent to a single peculiar formation known as the iron formation and commonly referred to as jasper.

(2) This formation consists of several varieties of rocks, differing in some cases widely in appearance, but closely related in ultimate chemical composition. Some of these varieties are known to be favorable to the occurrence of ore, while others are unfavorable.

(3) Many ore bodies occur on or against sheets of intrusive diorite.

(4) Other ore bodies occur in structural troughs.

(5) Most ore bodies occur in topographical depressions.

* Geologist, The Cleveland-Cliffs Iron Company.

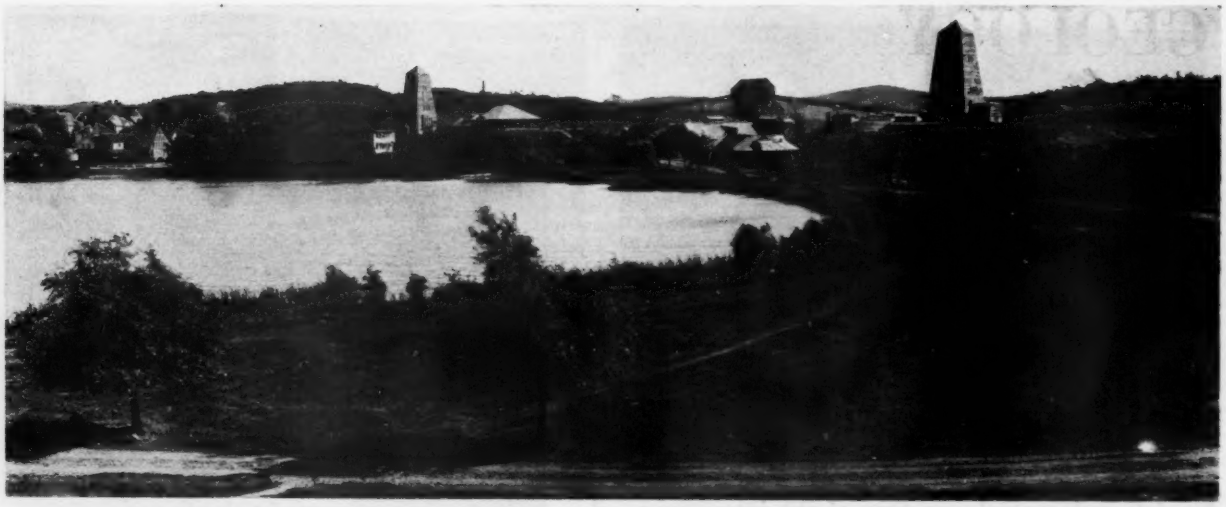
The iron formation, which contains all of the ore bodies making up the mines of the company, is known in the geologic scale as the Negaunee formation and is an altered chemical sediment. It occupies the uppermost part of the middle Huronian series of rocks in the Algonkian division of the pre-Cambrian system which covers such large areas of ledge surface in the Lake Superior District. Immediately below the Negaunee formation and also in the Middle Huronian is the Siamo slate. Above the Negaunee formation lies the Upper Huronian series, the lowest member of which is the Goodrich quartzite, known locally as the Ishpeming formation. There is a distinct unconformity between the Middle and Upper Huronian which in most places is represented by varying thicknesses of conglomerate.

The general structure of the Marquette Range is that of a great synclinorium of these Huronian rocks between two areas of Archean, constituting a great canoe-shaped basin, striking approximately east and west with a general pitch downward to the west. This basin comes to a point at the eastern end of the district, but not at the western end. A separate fold near the western end of the Range brings the iron formation around into a north-west south-east trending trough, which comes to a point at the town of Republic and contains the Republic Mine.

Besides these bedded rocks, there is a great volume of intrusive diorites, associated especially with the Negaunee iron formation in the Ishpeming-Negaunee area. These rocks are not themselves carriers of ore bodies but they are usually associated with the ore. For this reason, their limits and their relations with the iron formation demand most attentive consideration.

GEOLOGY OF ORE OCCURRENCE

Generally speaking, the iron ore on the Marquette Range is the result of the oxidization of cherty iron carbonate and silicates and a concentration of the resulting oxides by the solution and removal of the silica content or chert and the downward transportation of these oxides. The cherty iron carbonate and silicates are considered to be the original chemical sediments which make up the



The Cliffs Shaft Mine

greater portion of the Negaunee iron formation. Most of the original iron carbonate, even where concentration has not taken place, has been oxidized, forming the jasper mentioned above. The important things in regard to ore occurrence are connected with the "diorites," and their relations with the iron formation; with the iron formation itself, its thickness and state of oxidization; and with the favorable structures and their depths.

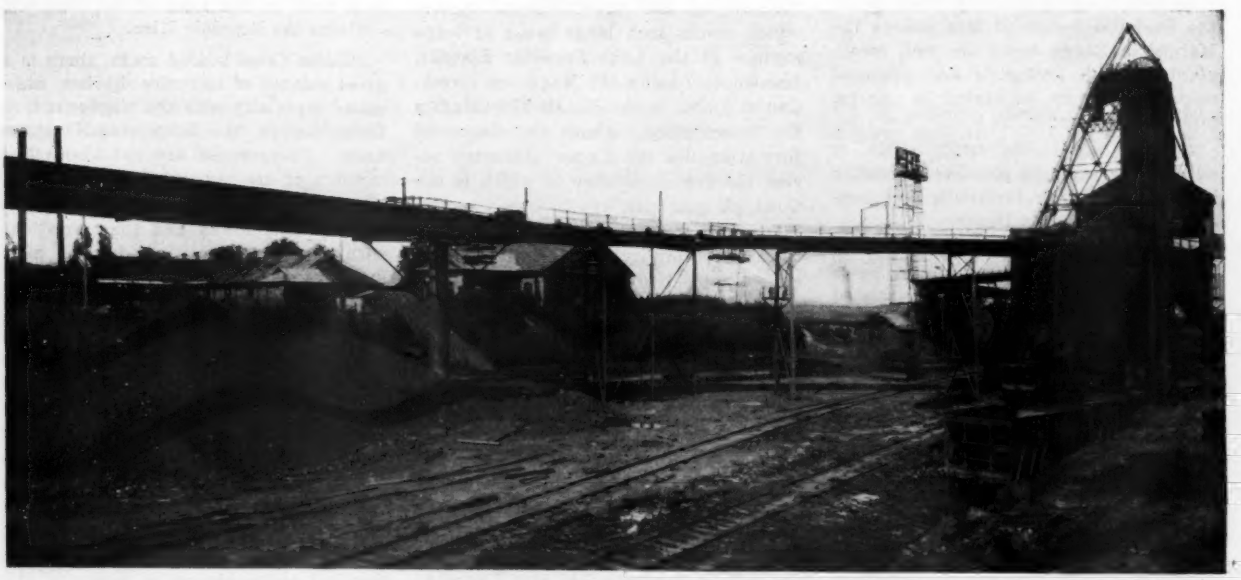
The Diorites

The intrusive igneous rock which we on the Marquette Range always, though incorrectly, call diorite is very common in all of our mines in dike formation. Also enormous bodies of it, flattened into sheets, in general parallelism with the bedding, occur frequently in the iron formation, but much more rarely in the underlying slates, and apparently not at all in the other rocks. These sheets contain many engulfed inclusions or slivers of the iron formation; on their edges they split into thinner sheets; from their upper surface they have sent out numerous dikes; and they form the footwall of several important mines. Where erosion has carried away the rocks above them, they outcrop over great areas. Altogether they are a conspicuous feature in the landscape and in the geology of the Range.

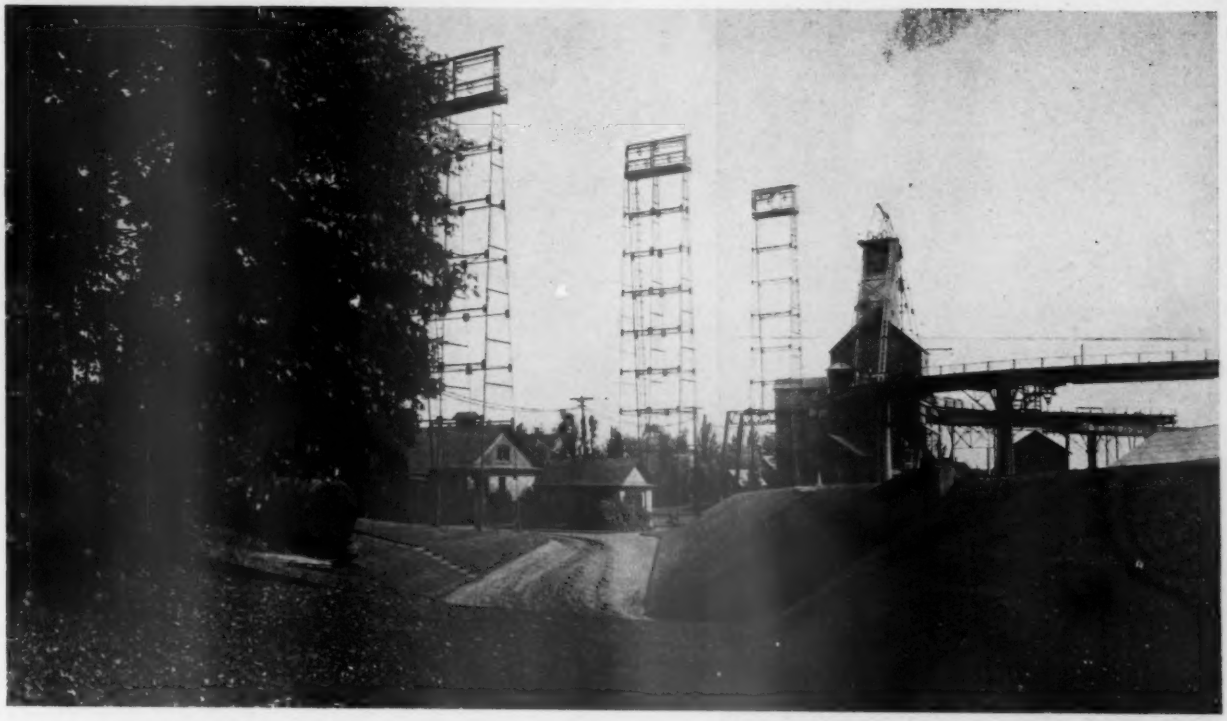
We have learned that these large bodies are not bosses, as some geologists have imagined, crossing the iron formation and widening out in depth, but are true sheets spreading out latterly in the iron formation (though, of course, fed from one or several sources from below), and favoring, particularly, two general horizons. We know that they have this form from studies of their contacts at the surface, and especially because we have drilled and mined through them and under them in a dozen places.

The intrusion of the diorites has produced distinct contact effects in the iron formation at and near the junction where the latter was unoxidized. These principally consist of a change of a part of the iron carbonate to magnetite, without a general recrystallization, and do not extend far from the contact. At the lower contacts, the effects are still more marked and new iron silicates in quantity even are formed. But these also do not seem to extend very far from the contacts.

The intrusive diorites seem to be older than the upper series; that is, the Upper Huronian rocks. Fragments from the diorites occur in the overlying conglomerates; and their upper surface, when



General view near the Negaunee Shaft



The Athens Mine

near the contact, and their off-shoot dikes, seem to have undergone an ancient weathering and the weathered products a recrystallization.

Their chief interest to us is the part they have played, both as dikes and sheets, in the concentration of ore, and in the protection from oxidization which they have afforded to the iron formation beneath them.

Thickness of Iron Formation and Depth of Oxidation

The iron formation of the Marquette Range from Negaunee west to North Lake has a thickness greater than any other iron formation known in the Lake Superior region, being in places at least 2,000 ft. Furthermore, it is cleaner and freer from slate and other contaminating material than any other iron formation known. The old Menominee iron formation is more than half slate. The Gogebic and Mesaba formations have many slate bands. The Marquette has practically none. Only on the south side of the Range, in the Cascade area, and a little ways north, is there an important mixture with clastic material, producing the flaggy jaspers which occur to some extent in this area and thicken to the south as the old shore line is approached. Since concentration of ore is the result of the oxidization, solution and downward transportation of the original iron of the rock, as well as the removal of silica, a thick formation without impervious bars or layers of slate is more favorable than a thin one.

There are a number of deep shafts and drill holes on the Range, some extending down 3,000 ft. With the exception of occasional interbedded horizons, which have been securely sealed by the intrusive dikes, oxidation of the iron formation has been found to be complete to these depths.

Ore

Both hard and soft ores occur in our mines on the Marquette Range.

Hard Ore: The hard ores are found only in one position, namely, in a zone not over 300 ft. thick at the top of the iron formation and immediately below the conglomerate, quartzite, or slate which happens to be the lowest member of the upper or Ishpeming series. These ores are the oldest of the Range. They are hard because of age, deep burial, compression and other alterations of a long and complicated history. They are now produced in only two of our mines, the Cliffs Shaft and Holmes; the Republic Mine, which for many years produced a large tonnage of this ore, having been exhausted a little more than a year ago.

The hard ores were originally made or concentrated at or near an old land surface when the rocks were flat or gently inclined. They have since been folded. Hence the ore has little dependence on present structural features, such as folds and faults.

Soft Ore: There are two important positions in which soft ore is found on the Marquette Range, namely:

(1) On top of the great diorite sheet and not far below the hard ore horizon in a small area in the southern part of Ishpeming.

(2) In the lower 300 ft. of the iron formation and generally close to its contact with the footwall slate.

(1) *Soft Ore on the Great Diorite Sheet*

The position on top of the great diorite sheet is that occupied by the soft ore bodies of several mines which have been both important and profitable, namely, the Lake, the Lake Angeline, the Salisbury, and the Holmes. All of these mines, however, except the Holmes, have now been exhausted. Just why concentration in this position should have taken place is hard to say. Similar structural conditions have been found in a number of other places and have been explored without successful results.

(2) *Soft Ore On or Near the Footwall Slate*

We find soft ore at the lower horizon under two somewhat different circumstances: (A) At the bottom of the main basin in minor folds, and in crotches formed by fault and dike intersections with the footwall slate; and (B) on the north side of the main basin from Negaunee westward to North Lake in a series of deposits much more widely distributed than the deposits in the bottom of the basin. Some of these, however, may prove ultimately to be "droppers" into these troughs. The ore bodies forming the Maas, Negaunee and Athens Mines are typical of those of group (A), and those of the Morris-Lloyd Mine at North Lake are typical of group (B).

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By LUCIEN EATON*

A full description of the method of mining and equipment used at Cliffs Shaft Mine—Ore is mined from fifteen levels, and is a hard specular hematite—Ore from this mine is sold to more different customers than any other mine in United States.

MINING HARD ORE at Cliffs Shaft Mine

THE Cliffs Shaft Mine has the distinction of selling ore to more different customers than any other mine in the United States. It is the largest producer of hard specular hematite in the country, and has a gross production of nearly ten million tons. It is an old mine and has produced ore for more than 40 years. The workings are quite extensive, and are scattered through a block of ground 6,000 ft. long east and west, 1,400 ft. wide north and south, and 700 ft. thick.

The ore was first discovered by diamond-drilling from surface on lands owned by the Iron Cliffs Co. When the Iron Cliffs Co. and the Cleveland Iron Mining Co. were consolidated to form The Cleveland-Cliffs Iron Co. adjacent hard ore lands became available for the Cliffs Shaft Mine, and the workings have been extended. Additional land on the north side of the mine has been acquired in recent years by a lease from the Oliver Iron Mining Co., and the workings have been extended into this territory also.

The ore is a hard specular hematite, low in silica and moisture and containing appreciable amounts of lime and magnesia. The iron content is high, about 59 percent natural, phosphorus 0.100 percent, and silica 5 to 7 percent. It is separated into two grades, "lump" and "crushed." The physical structure, low moisture, and low silica content make the lump ore especially desirable for the open-hearth furnace, and the crushed ore is an excellent addition to blast-furnace charges for increasing the output.

It is the unusual suitability of the lump ore for open-hearth furnaces that has led to its sale to such a large number of customers.

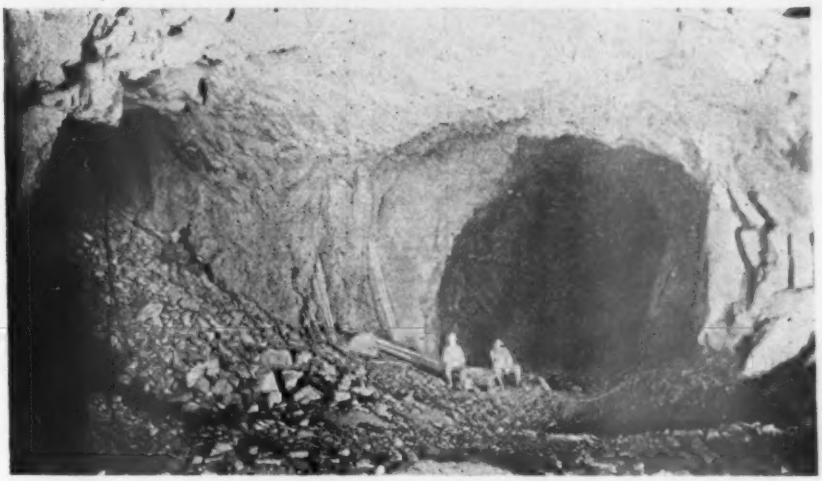
The ore occurs in the Upper Marquette Series of Huronian age, and is overlain by the Ishpeming quartzite and slate, with a footwall of jasper and altered diorite. It occurs as an irregular bed, badly folded and faulted, varying in thickness from nothing up to 100 ft., with an average of 25 to 30 ft. in the larger ore bodies. There is an unconformity between the ore and the hanging wall and probably in many places between the ore and the footwall.

The ore probably was originally one bed, but has been subject to much folding and faulting, and is now found in a number of so-called "veins" and lenses, which give a multiplication of ore bodies on one level. In general the main structure is a syncline with its axis nearly east and west, pitching downward in both directions from the middle. Both sides of the syncline are present only near the middle, one side or the other having been removed by erosion or displaced by faulting in the other parts of the mine. Other veins are found both north and south of the syncline, but were probably parts of the original bed. There are no outcrops at the mine, and the ore formation is overlain by quicksand 50 to 100 ft. in depth. Three major longitudinal faults have been recognized, and several minor longitudinal and cross faults are known to exist. The dip of the ore is irregular and in general is too low for the ore to run on the footwall by gravity.

The mine is opened by two vertical shafts 820 ft. apart and 1,060 ft. deep. They are of the same design, 10 ft. x 14 ft. inside timbers, and are divided into two equal compartments, one for hoisting and one for ladders, pipes, electric cables and counterweight. Both shafts were "dropped" through 60 ft. of quicksand to the ledge and cut the ore at approximately 400 ft. "A" shaft was sunk successfully in 1880, and "B" shaft was started a year later, but was temporarily lost in the quicksand and lay idle for two years. Each shaft was originally

* Superintendent, Ishpeming District, The Cleveland-Cliffs Iron Company.

Underground scene. Note scraper at right, and hoist in left foreground.

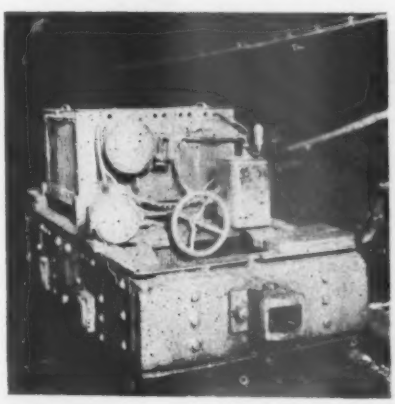


A stope in the Cliffs Shaft Mine.

equipped with a cage large enough to carry a 2½-ton car, but in 1910 these were replaced by 5-ton Kimberly skips, counterbalanced by a counterweight running in a 12-in. pipe.

To the visitor one of the most unique features of the mine is the shaft-houses, which are built of reinforced concrete somewhat in the shape of obelisks. They are 97 ft. high and 36 ft. square at the base, and each contains 640 cu. yds. of concrete. Even the floor-beams and the beams for carrying the sheaves are made of concrete. The shaft-houses were built in 1919 to replace wooden structures. Structural steel was very expensive at this time, and the concrete buildings were erected for little more than half the cost of steel. They were erected without delaying or stopping the operation of the mine.

Two-ton battery locomotive, Cliffs Shaft Mine.



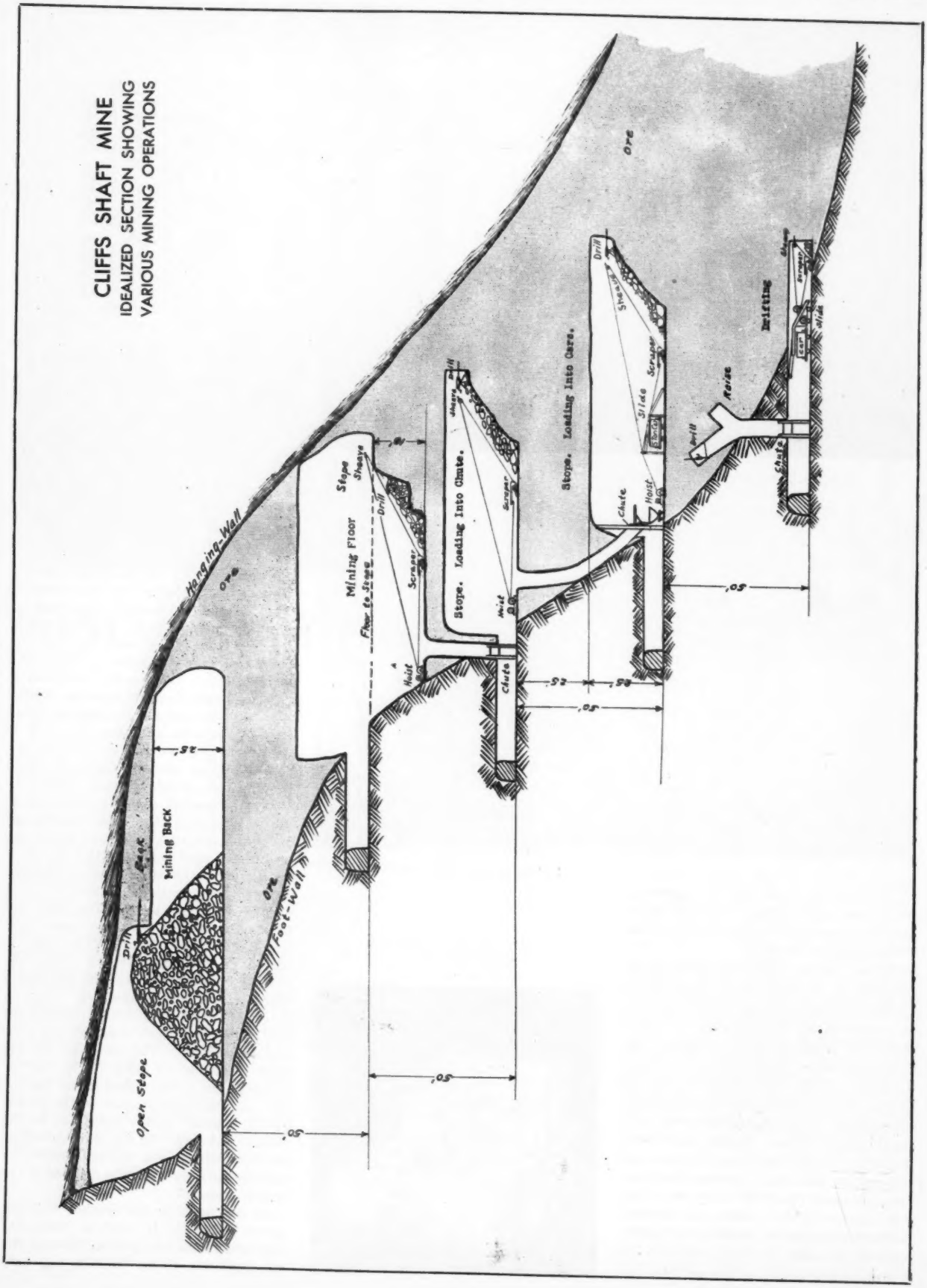
The engine-house is between the two shafts, and houses the hoist, two PRE Ingersoll-Rand air compressors of 2,500 cu. ft. capacity each, driven by synchronous motors, and a 1,200-cu. ft. Allis-Chalmers straight-line air compressor, also electrically driven. There is also a Nordberg, cross-compound, steam-driven compressor of 4,000 cu. ft. per min. capacity, but this is used only when there is a scarcity of electric power. There are also two 100-hp. motor-generator sets, made by the General Electric Co., for supplying 250 volts, D. C., to the trolley locomotives underground.

The hoist is an old one that has been rebuilt more than once, and consists now of two independent drums mounted on the same bedplate. The drums are 10 ft. in diameter with an 8-ft. face grooved for 1¼-in. rope, and are keyed to the shafts. They are driven by two 500-hp. General Electric induction motors through single reduction herringbone gears, made by the Falk Co. Each drum is provided with a Lilly hoist control. The hoisting ropes are 1¼ in. in diameter and run over light cast-steel idlers to the head-frames. The head-sheaves and turn-sheaves are of the bicycle type with removable steel liners in the groove and were made by the Lake Shore Engine Works.

As there is only one hoisting compartment in each shaft, it is necessary to take the skip off and put the cage on when the men go on or off shift and at the noon hour. The cages are fully inclosed and have two decks, 15 men riding on each deck. The change from skip to cage and cake to skip is made in five minutes, two and a half minutes being required for each operation.

In each shafthouse there is an ore pocket holding five skip loads, or 25 to 30 tons, into which the skip dumps directly. From this pocket the ore is drawn off into a steel side-dump car of 116 cu. ft. capacity, which is hauled up an inclined steel trestle, with a grade of 10 percent, to a steel crusher building halfway between the shafts and a little to the south of them. The cars are hoisted in balance, and the power consumption is very small. The hoist is placed on the ground level under the crusher building, and has one 4-ft. drum with a single herringbone gear bolted to it. It is driven by a 100-hp., 2,200-volt, A. C. slip-ring motor made by the General Electric Co. The controller for the hoist is on the top floor of the crusher building, where the operator can see the cars and can spot one car at the pocket by the position of the other car in the crusher building. On the pinion shaft of the hoist there is a solenoid brake, so that the cars are instantly stopped if the current goes off.

As the track in the crusher building serves both cars, it must be level, and some means must be provided to pull the cars back out of the building and onto


CLIFFS SHAFT MINE
IDEALIZED SECTION SHOWING
VARIOUS MINING OPERATIONS
Ore
Hanging-Wall
Ore
Mining Floor
Floor to Stope
Stope
Shaft
Drift
Drill
Scraper
Stope. Loading Into Chute.
Hoist
Chute
Stope. Loading Into Cars.
Slide
Raise
Drifting
Mining Back
Rock
Open Stope
Ore
Foot-Wall
25'
05'
52'
58'

the incline. This is accomplished by a counterweight, which is picked up by the car as it enters the building and is dropped again as it starts down the incline. The cars are dumped by a 12-in air lift mounted horizontally on the beams overhead.

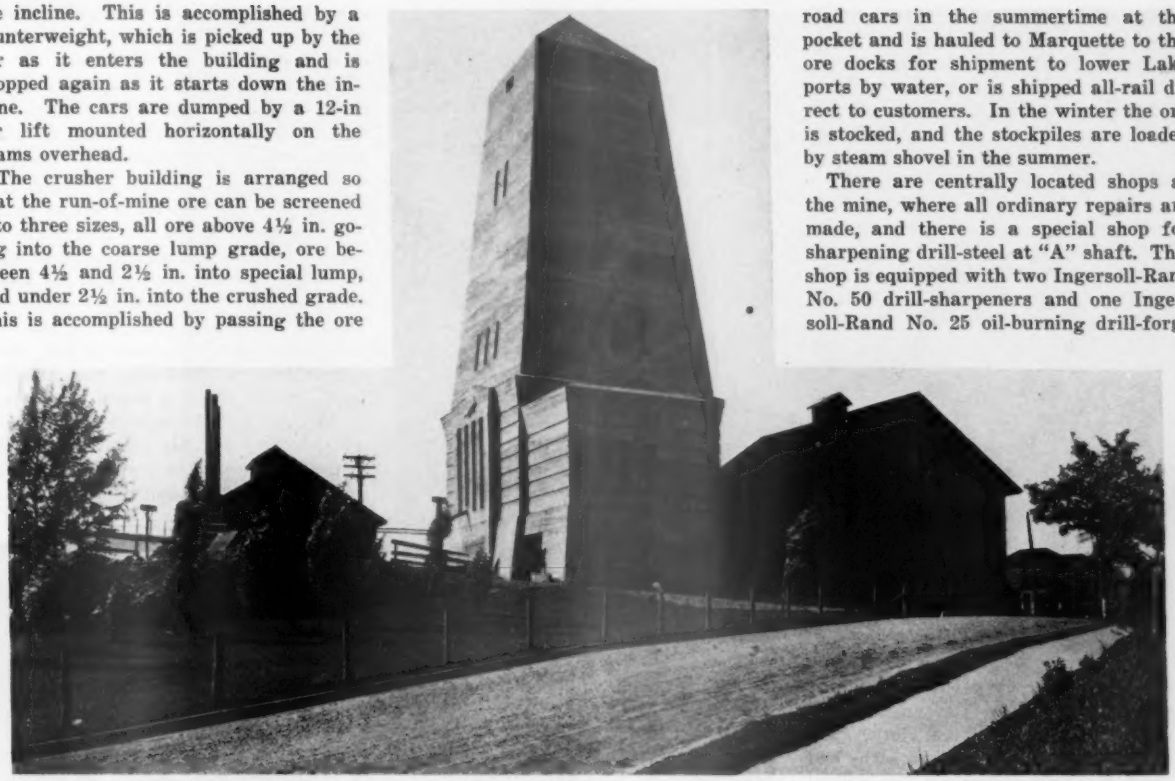
The crusher building is arranged so that the run-of-mine ore can be screened into three sizes, all ore above 4½ in. going into the coarse lump grade, ore between 4½ and 2½ in. into special lump, and under 2½ in. into the crushed grade. This is accomplished by passing the ore over a rotary disc grizzly, bought originally from the Stephens-Adamson Co., with 4½-in. openings, and by screening the ore passing through this grizzly in a 4 ft. x 12 ft. revolving screen.

Ordinarily, however, the entire product is passed through a No. 8 McCully crusher set at 9 in., which reduces the size of the largest lumps, but makes very few fines. The product from this crusher passes through a 4-ft. x 12-ft. revolving screen with 2½-in. holes, the oversize going into the lump grade, and the undersize into the crushed grade.

Provision is also made for crushing the entire product to 2½ in., should this be necessary. The ore is loaded into railroad cars in the summertime at the pocket and is hauled to Marquette to the ore docks for shipment to lower Lake ports by water, or is shipped all-rail direct to customers. In the winter the ore is stocked, and the stockpiles are loaded by steam shovel in the summer.

There are centrally located shops at the mine, where all ordinary repairs are made, and there is a special shop for sharpening drill-steel at "A" shaft. This shop is equipped with two Ingersoll-Rand No. 50 drill-sharpeners and one Ingersoll-Rand No. 25 oil-burning drill-forge for heating for forging. The drills are heated for tempering in a Sullivan oil-burning forge equipped with an indicating pyrometer. There is also a power hack-saw for cutting steel, and a pedestal grinder and drill for finishing shanks. In this shop all the steel for this mine and part of the steel from another mine are sharpened.

The change-house or dry was the first



The concrete "A" Shaft House of the Cliffs Mine.

Four-ton battery locomotive, Cliffs Shaft Mine.

Six-ton trolley locomotive, Cliffs Shaft Mine.

Above—The Eaton hoist and a pneumatic drill.

Right—A scraper hoist in a stope in the Cliffs Shaft Mine

of the fire-proof modern dries built in the district, and was erected in 1901. It is equipped with hooks for underground clothes and lockers for street clothes, and has a wash-room with shower baths and basins, a latrine, first-aid room and boiler room. There are accomodations for 250 men.

Up to 1910 steam-power only was used at the mine, but in that year electrification began and was continued until complete. The old steam-plant, however, consisting of five 150-hp. boilers, equipped with automatic stokers and economizer, is retained, and can be put in service at a few hours' notice.

Electric power is bought from the Cliffs Power and Light Co., a subsidiary of The Cleveland-Cliffs Iron Co., and is delivered at the mine at 2,200 volts, a. c., three phase, 60 cycles. The large motors nearly all use 2,200-volt current, and for the smaller sizes the voltage is transformed to 440 and 220 volts. Over 400,000 kilowatt hours are consumed per month.

There are 15 levels in the mine, and on nearly all of them some work is being done. The first level is at 340 ft., and the level interval is 40 ft. for four levels and thereafter 50 ft. The fifteenth level is at 1,000 ft., 430 ft. above sea level. Between the tenth and fifteenth levels the levels do not go to the shaft, all ore being transferred to the fifteenth level through chutes.

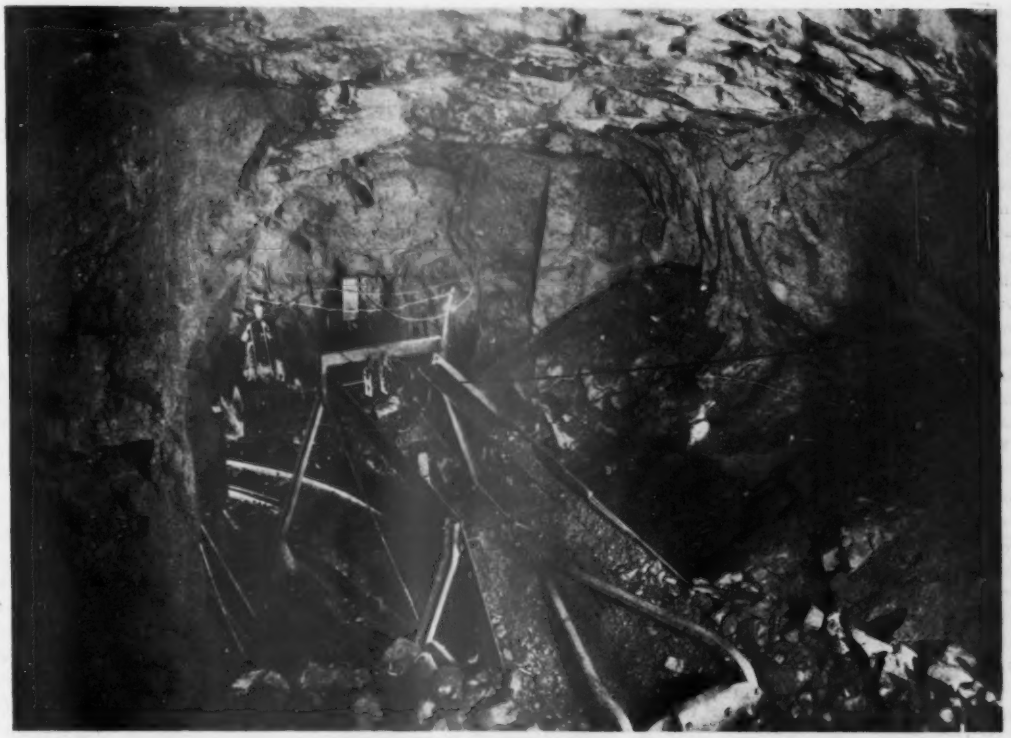
The main pump-house is on the fifteenth level near "A" shaft, and there are auxiliary pumping stations with steam-pumps on the fourth and tenth levels in the same shaft. The mine makes about 900 gallons of water per minute, and this is pumped to surface, 1,000 ft. in one lift. There are two Prescott duplex horizontal pole-pumps of 600 gals. per minute capacity each geared to General Electric motors, and one direct connected centrifugal pump, also made by the Prescott Co.

The mining method used is that of open stopes with pillar support. The rooms are normally 25 ft. high and 25 ft. wide, and are advanced by breast stoping. On the upper levels floors are only 15 ft. thick, but below the fifth level they are 25 ft. thick. A large percentage of the floors, between the pillars is recovered, but no attempt is made to recover the pillars themselves, as the ore is overlain by quicksand and much of the mine is under the city.

In advancing a room a cut 7 or 8 ft. high and as wide as the stope is driven 10 ft. ahead of the bench, which is taken up afterwards by lifting holes drilled horizontally. The cut is driven by slabbing holes, and advantage is taken of slips wherever possible. The success of the method depends largely on keeping the corners ahead and properly squared up. When the cut is far enough ahead, the breast is drilled again but not blasted, and the broken ore is cleaned off the bench. Lifting holes 8 to 10 ft. deep are drilled 5 or 6 ft. apart in horizontal rows with a burden of approximately 5 ft. The whole breast is then blasted at one time.

As the bottom holes do not reach in as far as those above, a toe is left as a start for a new bench, and the broken ore lies on this toe in a pile high enough to allow the miner to reach the back at the breast conveniently. The back and breast are then trimmed, and drilling for the next cut is started. This method has many advantages. It facilitates trimming the back, always leaves a bench or a pile of broken ore for the miners to stand on, and provides a fairly continuous supply of broken ore for the trammers. It also gives a good opportunity for picking out rock before it has been discolored by the ore. As there are many seams of slate in the ore, this is very important.

When the ore in a breast stope does not extend up to the next level, it must be mined by back stoping. In starting this operation a stage is built with ladders and 3-in. planks, and from it as many holes are drilled as possible. These holes are charged, the stage is taken down, and the holes are fired. The stage is erected again, more holes are drilled, and the operation is repeated until the pile of broken ore is high enough for the miners to reach the back without the stage. The stope is carried up to the top of the ore, and then advanced longitudinally over the stope below. The ore is broken down by horizontal holes drilled in rows; these holes can often carry a 6-ft. burden. At this stage the trammers usually start at the other end of the pile of broken ore, and tram it out as the stope advances, always leaving enough ore for the miners to stand on.



A scraper slide in the Cliffs Shaft Mine.

A 25-horsepower scraper hoist.

In mining floors, present practice is to work on a sublevel instead of mining the entire 25 ft. and dropping the ore to the level below. In starting, a raise is put up, a chute erected, and the ore around the raise is milled into it by underhand work down to a depth of 18 ft. When the ore will no longer run into the chute by gravity, it is shoveled by hand and later dragged by scrapers. The scrapers are particularly effective in this work because the footwall is often so flat that the ore would have to be rehandled several times if it were shoveled by hand. Raises are usually about 100 ft apart, as the scrapers can easily reach 50 ft. in either direction from the chute. When the ore has all been mined down to the floor of the sublevel, the remaining 7 ft. can be mined in one lift and dropped to the level below.

The extraction in wide bodies is approximately 65 percent, but in narrow ore-bodies with strong walls standing nearly vertical it may be as high as 90 percent. The average for the mine has been 72 percent. An idealized section showing the different kinds of stoping is shown on next to last page.

The ore is tough and hard to drill, and stands well on exposure to the air. As the hanging-wall slate, when exposed, tends to slack off, it is customary to leave 2 or 3 ft. of ore on the contact as a protection.

The drills used are of the Leyner type and are mounted on tripods without weights. They all have hammers 3½ in. in diameter, and weigh about 150 lbs. each. Three makes are used, the D8T made by the Cleveland Rock Drill Co., the N-75 of the Ingersoll-Rand Co., and the T-3 of the Sullivan Machinery Co. All use 1¼-in. hexagon hollow drill-steel without lugs.

Fifty percent ammonia powder is used in sticks 1½-in. x 8-in. in size. All fuse is cut and capped on surface in a fuse-room at the dry, and is carried underground by the miners in flat circular cans, nine inches in diameter and three inches deep. All the capping and cutting is done by one man with a California safety cap-crimper.

The ore breaks in large pieces, so that a good deal of sledging and secondary blasting are required. The largest pieces are blockholed for blasting, and the flatter pieces are bulldozed. This work is done by the miner as part of his contract.

For blockholing small jackhammer drills, using ⅞-in. hexagon hollow collared steel are used.

Some of the ore is loaded by hand into 2½-ton end-dump cars, the work being done by contract. A few of the old wooden cars are still in use, but the new

cars are built entirely of steel, and are equipped with either ball or roller-bearings on the axles.

Most of the ore is loaded by scrapers either into chutes or directly into cars by means of slides. There are now over 50 scrapers and hoists in the mine. The scrapers are all of the hoe-type with manganese steel blades and side-plates, and weigh 1,500 lbs. apiece. The hoists are all of the double-drum type made by the Lake Shore Engine Works and have band-clutches and planetary transmission. Nearly all are driven by 25-hp., 900 r.p.m., 440-volt, a.c. squirrel cage motors made by the General Electric Co., but a few are driven from the trolley circuit by 250-volt d.c. compound wound 15-hp. motors.

Alternating current is brought into the mine at 2,200 volts, and is transformed to 440 volts at convenient points on several levels. The current is transmitted through 3-conductor lead covered and armored cables hung on ⅜-in. messenger wire, and there are over seven miles of such cables in the mine. All of the minor connections are made with Arktite couplings, made by the Crouse-Hinds Co., and these have been developed into a very convenient form, so that there is little delay in laying or connecting cables.

The slides are of two types, semi-permanent and portable. The semi-permanent slides are used for loading cars in stopes. They are made entirely of steel, and are bolted together. They must be taken apart to be moved. The standard 48-in. scraper and 25-hp. hoist are used with them.

The portable hoists are intended for use only in drifts and cross-cuts. They are mounted on wheels, and can be easily moved. On these slides the motor is 15 hp. d.c., and the scraper is 42 in. wide and weighs 625 lbs. They have not been in use long, and are not yet standardized. Every scraper outfit is equipped with a flood light.

The standard chute in use underground is the Alaska-Treadwell finger chute slightly improved. Normally for 20 ft. above the chute the raise is put up at an angle of 45 degrees and is then turned to right or left or upward, so that the velocity of the ore in falling will be checked by the elbow thus formed. The chute itself is made of 3-in. hemlock plank and is lined with ⅜-in. boiler plate.

The chute-closers are fingers made of 4 x 6-in. fir, protected by steel and manganese steel wearing-plates. These are hinged at the top of the chute opening in such a way that they press down on the stream of ore in stopping the flow. Below them there is a steel apron to catch the spill. These chutes are very desirable and make rapid loading of cars easy.

On the fifth, eighth, tenth and fifteenth levels hauling is done with 6½-ton, double-motor trolley locomotives made by the General Electric Co. These haul 5-ton rocker-dump cars made by the Lake Shore Engine Works and the Koppel Industrial Car and Equipment Co. These cars dump into single pockets at the shafts. The pockets hold one skip-load, but are rarely used except as chutes, because there are too many delays from being blocked by chunks, when they are filled. With this type of car the loading time is only 10 to 12 seconds.

On the other levels storage-battery locomotives are used for hauling 2½-ton cars either to a chute or to the shaft. These locomotives are of three types. There are 4-ton single-wheel drive Goodman locomotives, 3-ton General Electric double-drive locomotives and 1½-ton Whitcomb locomotives. All but two of the storage-battery locomotives use Edison batteries.

On account of the irregularity of the size, shape and location of the ore-bodies an unusually large amount of rock drifting is necessary. Out of 80 working places 15 percent are in rock and 5 percent are drifting or raising in ore, preparing stopes for mining.

The standard drift is 8 ft. high and 8 ft. wide, and is untimbered. In drifting the same kind of drill is used as in the stopes, but the drills are mounted on 3-in. bars instead of tripods. Drilling and blasting is done by day, and the broken rock is loaded at night. This is the only work done at night, except pumping. All rock is dumped underground, either on the level, where it is broken, or on the second level, where there is a special set of dump-plates for the skip. About 20,000 tons of rock is dumped underground in this way each year.

The standard raise is 6 ft. x 6 ft. in cross-section, and is put up at an angle between 45 and 55 degrees. No timber is used, and the miners climb up and down on chain ladders. The drills used are either the same as those used in drifting and stoping, or else hand-rotated stopers, using ⅞-in. quarter octagon solid steel.

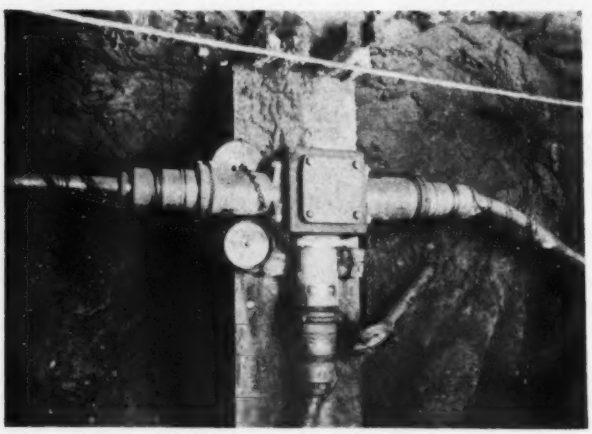
Although there is almost no timber in the mine, except in chutes, and although both the shafts are wet, nevertheless precautions are taken to prevent fires and air-doors are provided to stop the flow of air, in case of fire. These are all-steel doors erected at the proper locations and are released by small air-cylinders operated by compressed air. By opening a valve at any level at either shaft underground or on surface compressed air can be turned into a special system of pipes, and every door in the mine will close almost instantly. A stench alarm is also provided.

Every man working in the mine is required to wear a hard hat, and to have wire-gauze goggles, which must be worn when sledging or when starting to drill holes. All men handling wire-ropes must wear gloves. Each working place is also provided with a small brass whistle, connected to the compressed air-line, to be used as a warning, when blasting.

A large part of the mine is lighted by electricity and all the plats and the drifts near the shafts are whitewashed in order to increase visibility.

The mine, with the exception of tramming rock from development work, is worked only on day shift. Most of the working places are dry and the air is good. These physical conditions, coupled with the high degree to which mechanization has been carried, have attracted a high class of labor.

The grounds about the office and other mine buildings are planted with shrubs and flowers, and give the property an attractive appearance. The buildings on surface are also kept in good condition, and the neat appearance of the property is a source of pride with the organization, and has helped to no small extent in building up an admirable esprit de corps.



Junction box in the Cliffs Shaft Mine

THE NEGAUNEE DISTRICT
Underground Properties

By W. W. GRAFF *
and
CARL BREWER †

The three mines in this district are connected underground for ventilation and safety, but have separate shafts and surface equipment—All equipment is standardized and interchangeable as far as possible—Full description of method of mining and equipment.

THE mines operated at the present time by The Cleveland-Cliffs Iron Company in the Negaunee District are the Athens, Maas, and Negaunee, all of which are located in the eastern part of the city of Negaunee, Mich. They are all underground mines having separate shafts and surface equipment, and are connected underground for ventilation and safety. Both the surface and underground equipment and layouts are similar at these three properties although they vary in minor details. The method of mining is practically the same at the three properties with slight variations because of local conditions. The equipment is standardized and interchangeable as far as possible and is only varied from the standard for some special reason.

All the mines are electrified, the power being purchased from the Cliffs Power & Light Company. A transformer station at the Maas mine steps down the voltage from 33,000 volts a. c. to 2,200 volts a. c., which current is distributed by separate lines to each mine. This voltage is standard for all the larger machinery, hoists, compressors, motor-generator sets, pumps, etc.

*Superintendent and † Assistant Superintendent, Negaunee District, The Cleveland-Cliffs Iron Co.

W. W. Graff.

Carl Brewer.

The surface layout for these mines consists of mine office building with supply warehouse, brick engine house, brick dry, brick shop, laboratory, crusher house, and a few other buildings such as garage, storage sheds, etc. The shaft at each property is equipped with a steel headframe 110 ft. in height which is enclosed to make better operating conditions during the winter season. Each mine has a timber yard of from 2 to 4 acres extent that is connected by a con-

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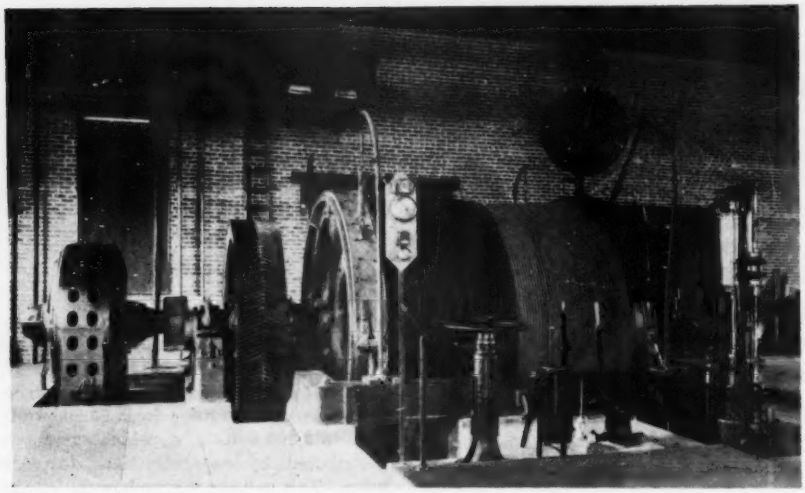
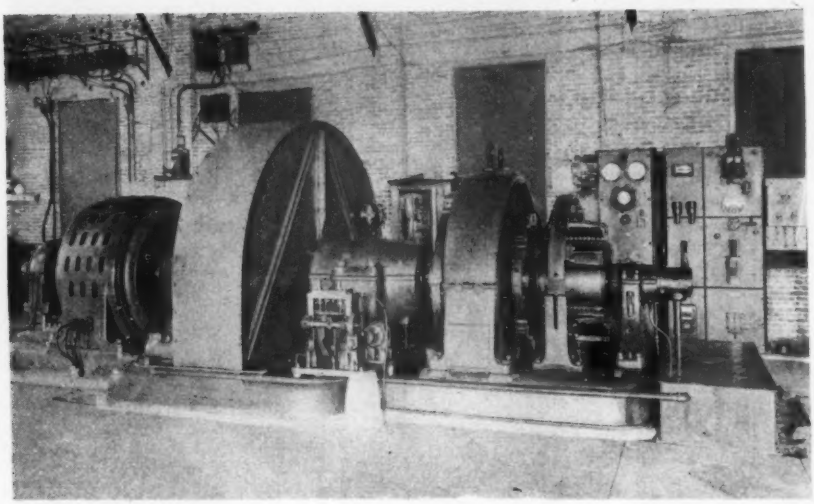
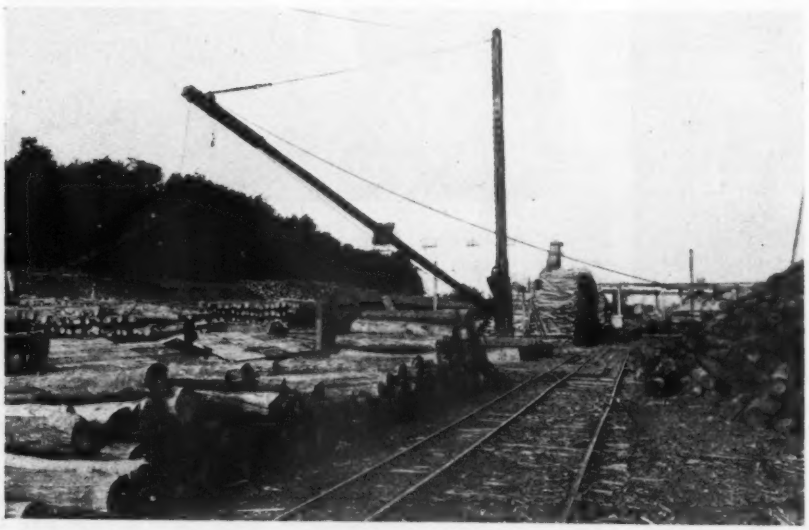


Cage hoist, Athens Mine.



Motor generator set, Ilgner system, Athens Mine.



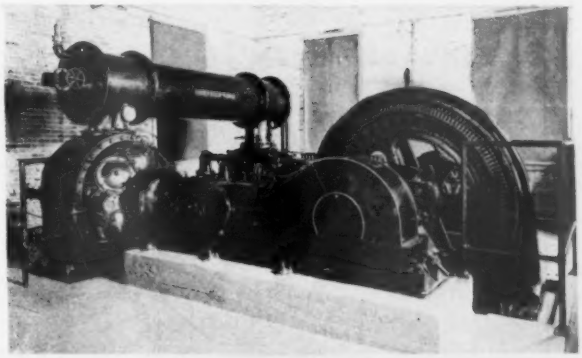
Treated timber and timber seasoning before treatment near the treating plant at the Athens Mine.

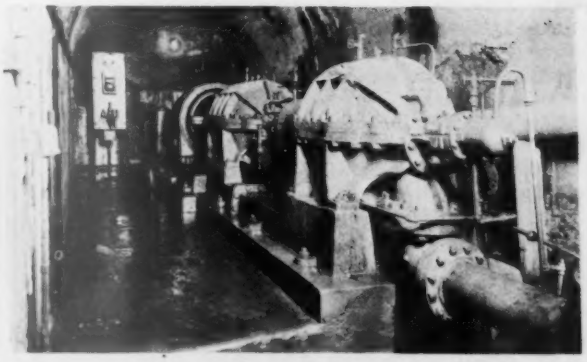
crete tunnel to the shaft to facilitate the handling of timber and other underground supplies. This tunnel has a covered connection with the dry house used by the underground men and also a connection by tracks directly to the shop buildings for handling equipment for repairs. The immediate vicinity of the mine buildings are fenced and landscaped under the personal supervision of Mr. Warren H. Manning, of Boston.

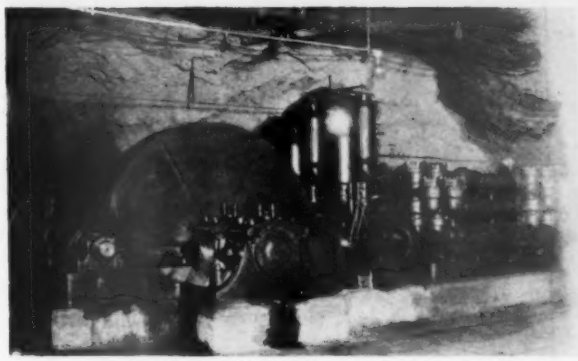
Owing to the necessity of stocking ore on surface during the time the lakes are closed to shipping, each mine is equipped with steel stocking trestles, the original idea of S. R. Elliott and the design worked out by the Wisconsin Bridge & Iron Company of Milwaukee. The first of these steel trestles was built at No. 3 shaft, Negaunee mine, in 1911. The steel trestles at the Athens mine were built in 1922 and the trestle at the Maas in 1928. These trestles are of similar design and are all built on the cantilever principle, from 35 to 48 ft. in height, having reinforced concrete columns 4 ft. in diameter at the top and 6 ft. at the bottom, spaced 114 ft. apart. Endless rope haulage systems are used, operated by 50 hp. motors using 2,200 volts a. c., connected through gears to 8-ft. rubber lined sheaves. Wooden saddle-back top tram cars are used, having the same capacity as the skips. Separate operating equipment is provided for each track and is run by the operator located in a fireproof engine house on the top landing. The steel trestles are always in service and the supporting columns do not interfere with loading operations of the steam shovels during the shipping season, while on the other hand, the wooden trestles have to be dismantled every spring and re-erected in the fall. There is a heavy loss in wooden trestles due to breakage and much delay due to derailments.

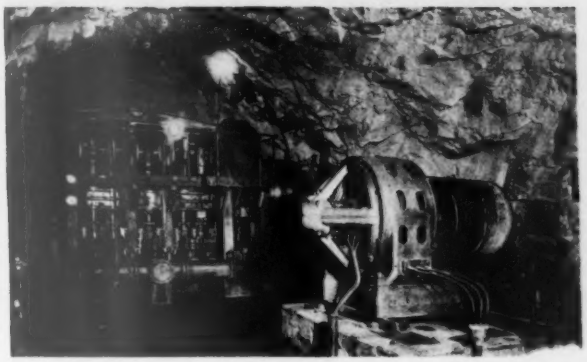
The operating shafts of the three mines are of The Cleveland-Cliffs Iron Company standard design 10 ft. 10 in. x 14 ft. 10 in. inside measurements divided into four compartments—two skip roads 4 ft. 3 in. x 5 ft. 1 in. located at one end of the shaft and a 3 ft. 1 in. x 10 ft. 10 in. ladder and pipe road at the other end, with a 6 ft. x 10 ft. 10 in. cage compartment between. Owing to the different depths at which the mines are being worked, the hoisting equipment varies at the three properties.

The main levels are approximately 9 ft. x 10 ft. in size, being timbered where necessary with wood sets at 5-ft. centers. Each set consists of an 8-ft. cap with 9-ft. legs set with a batter of 2 in. to the foot; the back is lagged and, where necessary, the sides also. Most of the timber sets used in main haulage drifts have been treated with 5 percent zinc chloride solution. An open tank timber treating plant was constructed at the Athens mine in 1923. It consists









Above—2,440-cu. ft. Ingersoll-Rand compressor, Negaunee Mine. Below—Prescott electric pump on 10th level, pumping against a 2,400-ft. head, Athens Mine.

Above—1,000-gallon Prescott centrifugal pump, Negaunee Mine. Below—Aldrich plunger pump on the 4th level of the Holmes Mine.

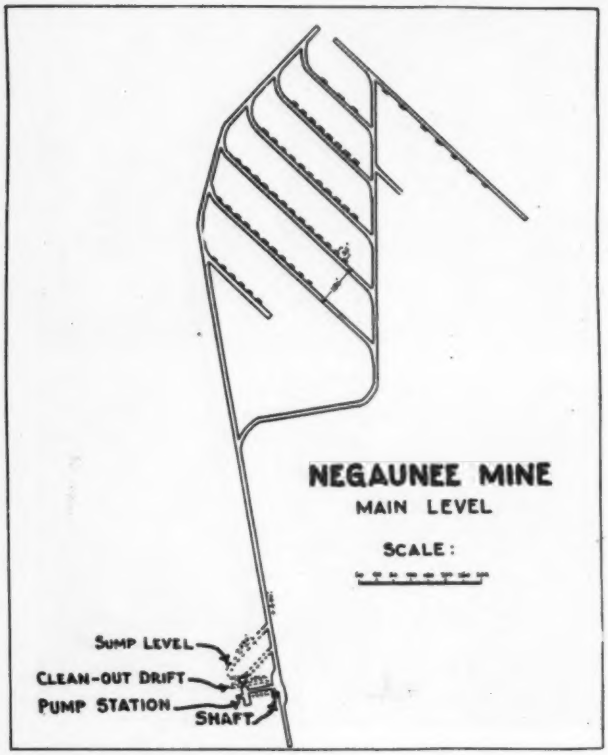
of two vertical steel tanks, 6 ft. in diameter, for treating and two steel storage tanks for the zinc chloride solution. The plant is operated about three months in the summer each year and has a capacity of 40 pieces of treated timber per day, which supplies sufficient treated timber for the company's mines. The timber treating plant was installed on account of the rapid deterioration of the timber on the main levels of the Athens mine. Actual tests in this property have demonstrated that the life of the treated timber is from 4 to 6 years as compared with 2 years for the untreated timber.

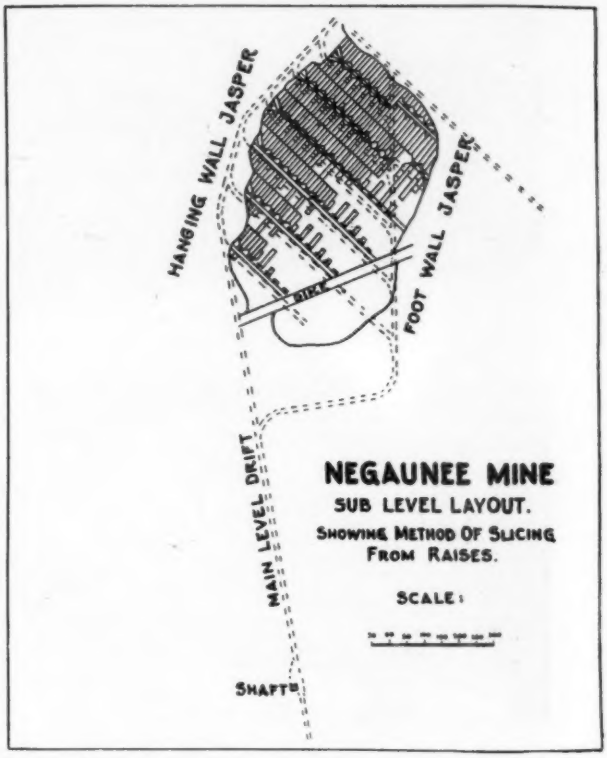
The main haulage levels are 100 ft. apart in the Negaunee mine, and 200 ft. apart in the Athens and Maas. They are driven in the footwall beneath the ore body. Parallel crosscuts are driven at 150-ft. intervals across the ore body from which two-compartment raises are put up at 35-ft. centers on 65° angles to the sub levels. All main level drifts are lighted at intervals of not over 200 ft. with 50 candle power lights directly connected to the trolley system and grounded to the pipe line; additional lights are placed at switches and chutes.

The ore handling equipment underground at the mines is similar and standard for the company. Each underground shaft station is equipped with three 50-ton compartment pockets with two measuring pockets, one for each skip. The older pockets were constructed of wood while the more recent installations are entirely of concrete. The main level haulage system consists almost entirely of 6-ton electric trolley locomotives manufactured by the General Electric Company operating on 250 volts d. c. At the Negaunee mine there is one 10-ton General Electric locomotive used to haul a 10-car train. Thirty-inch gauge tracks and 40-lb. rail are standard for all main level haulage tracks. Steel saddleback cars of 65 cu. ft. capacity are in use at all of the mines but these are gradually being replaced by solid body rocker dump steel cars.

The top slicing method of mining is standard for the three mines, with a 11-ft. interval between sub levels. The arrangement of main level crosscuts and raises block out the ore body into pillars 35 x 150 ft. on each sub level, the pillars being at right angles to the crosscuts with the raise in the center. The pillars are mined by one drift and two side slices 75 ft. in length on each side of the raise. Timber, 8 ft. in length (overall), is used for both cap and legs with a rake of 2 in. to the foot for the latter. Lagging is used where necessary on the sides and back. The floor is covered down with 9½-ft. poles nailed to three crosspieces. Under the hanging or near areas of lean ore the poles are laid close together, but where there is a timber mat overhead the poles are spaced about 6 in. apart. All open spaces between the drifts and slices are carefully cross-lagged. The sub level interval of 11 ft. has been adopted so that the sets of each sub catch up the floor covering of the sub above. This method does not leave any ore between the floor of one sub and the top of the timbering on the sub below, which fact has materially reduced accidents due to falls of ground, and also the amount of lagging required. This system of covering down, prevents runs of rock or lean ore from the back, which would contaminate the ore, thus giving a cleaner and more complete extraction. The results of this system, in use for less than a year, indicate a higher iron content.

Mechanical loaders are in general use throughout the mines, scrapers having superseded the Mayne loaders which were used for several years. Both air and electric scraper hoists are used in nearly equal numbers at the present time. The number of air operated scraper hoists is limited by the capacity of the air compressor plants, and the additional hoists needed have been electric. The electric hoists in use represent the development of these units from 6½ and 7½ hp. to larger units of 10, 15 and 25 hp. Electric scraper hoists manufactured by the Sullivan Machinery Company and the



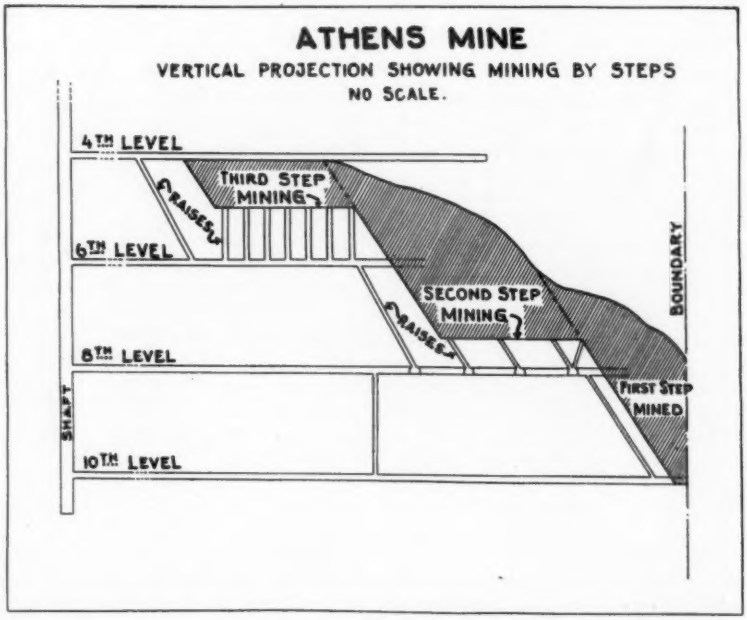


Gardner Denver Company are used, while the majority of air hoists in use are made by the Ingersoll Rand Company. The scraper found best suited for handling the ore is a modification of the box type, 36 in. square. Some larger scrapers 42 in. square are used with the 25-hp. electric scraper hoists for transferring ore in certain areas.

Standard operating methods for handling explosives, underground haulage, electric installations, timbering, covering down, etc., have been adopted at all company properties and these standard operating methods, together with plenty of light underground and safety devices, have reduced accidents to a low figure.

Negaunee Mine

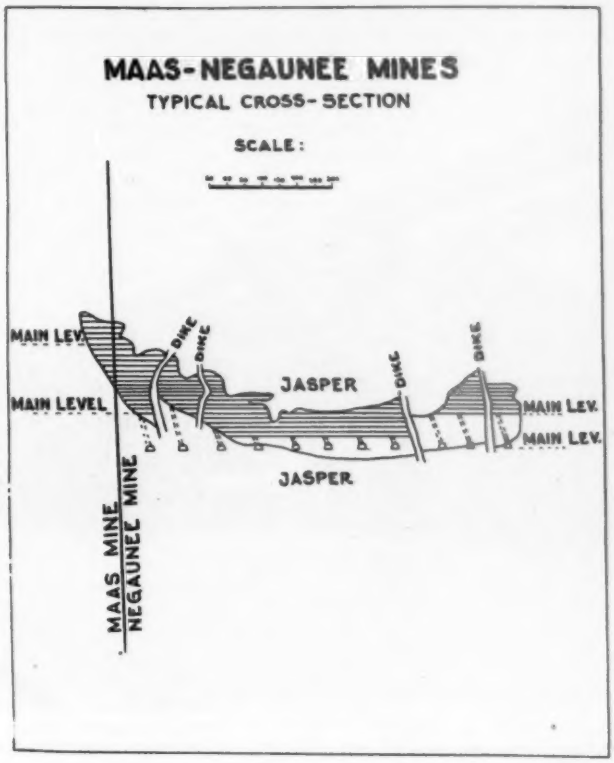
The Negaunee mine property is leased by The Negaunee Mine Company and is operated by The Cleveland-Cliffs Iron Company which owns a 50 percent interest, the Bethlehem Steel Company owning the other one-half interest. This mine is the largest underground producer among the soft ore mines operated by The Cleveland-Cliffs Iron Company. The product in 1928 was 454,563 tons. The maximum product was 554,609 tons in 1920. The product is all handled by two skips in one shaft. Ore is mined on the day shift only but is hoisted on both day and night shifts. Production is governed by sales and varies from year to year according to the demand. Up to January 1, 1929, the mine has produced 11,264,099 tons, of which 11,216,691 tons have been shipped.

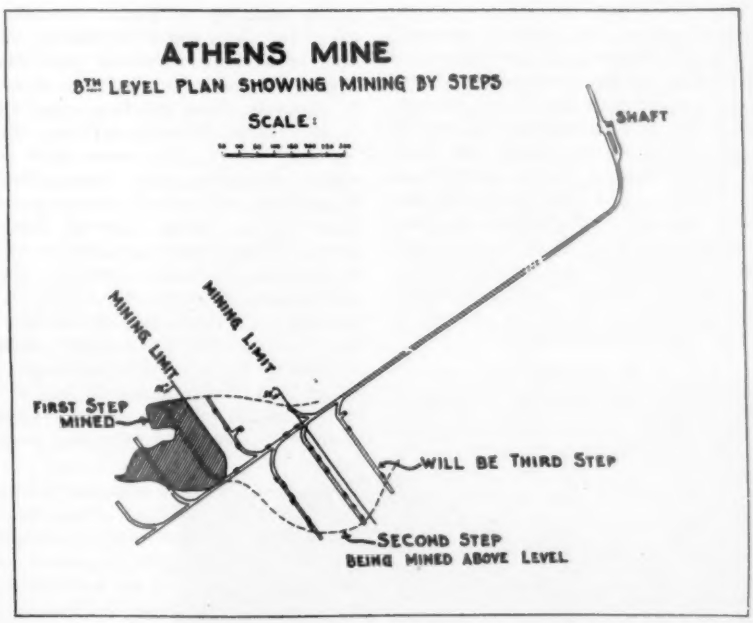


The mine was originally opened and operated by Captain Samuel Mitchell in 1887. In 1903 it was taken over by The Negaunee Mine Company. The ore was originally mined on the square set, open stoping and room and pillar system. The present company inaugurated the caving system with sub level top slicing.

The Negaunee and Maas mines are working in the same ore body—the Maas on the west side and the Negaunee on the east side of a wide trough pitching to the west on a slight angle. The footwall is a transition belt underlaid by slates and the hanging wall is jasper. The ore is a soft hematite of varying hardness and quality. There is some local faulting along two vertical dikes which extend in an east-west direction, but the displacement is not great.

The ore body has been developed from three vertical shafts, two of which have



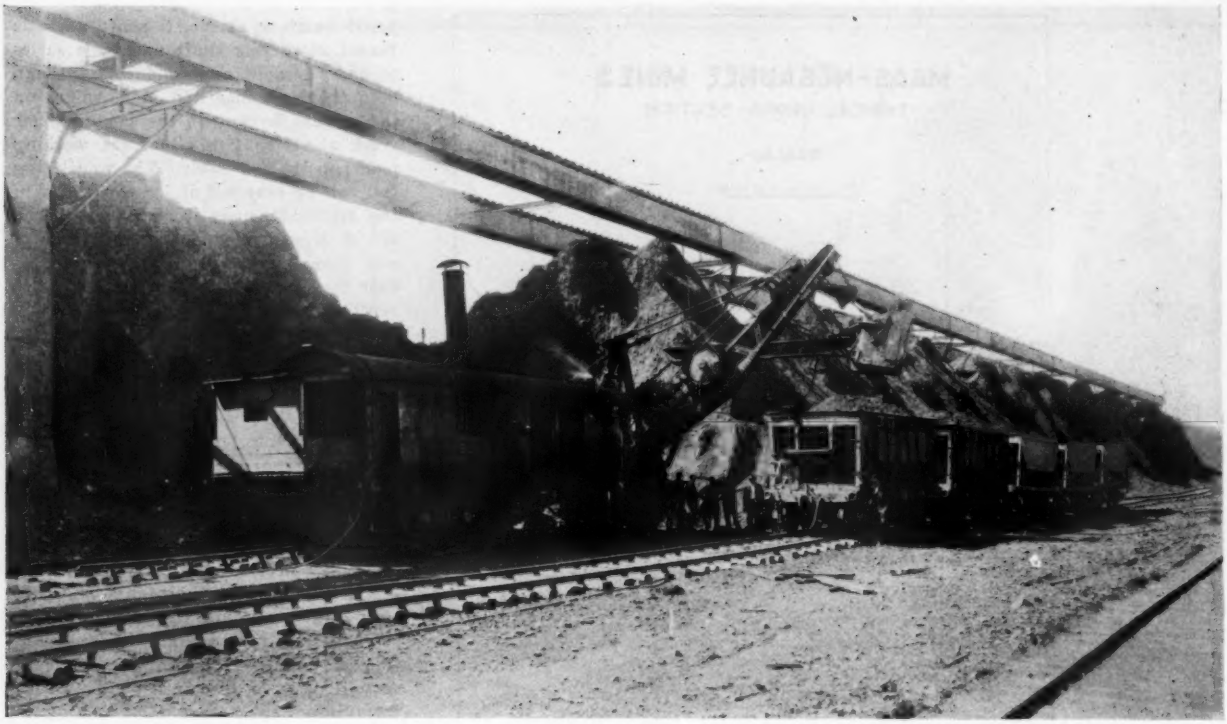


been abandoned for mining purposes. The present No. 3 shaft was sunk by The Cleveland-Cliffs Iron Company in 1910; it is circular, of standard design and is concreted to a depth of 942 ft. From the surface to the ninth level, 850 ft., this part of the shaft was stripped to a vertical raise which was completed in a single lift. The lower 308 ft. is rectangular with wood sets. Steel sets are used in the concreted portion of the shaft, and the skip roads are partitioned from the cage road by sheet metal to make that portion of the shaft fireproof. The bottom part of the shaft is quite wet and there is no danger from fire. As an extra safety precaution, all shaft stations are concreted.

Ventilation is provided for the Negaunee and Maas mines by a 100,000 cu. ft. per minute fan, operated by a 150-hp. Westinghouse motor, installed in a fireproof building at No. 2 shaft. Air is forced down this shaft and by a series of doors is split and conducted through both the Negaunee and Maas mines on the various levels. In the same manner fresh air is sent to all of the working places in the sub levels. The ventilating fan can be reversed if ice conditions in the air shaft make it necessary. Both No. 3 Negaunee and the Maas shafts are upcast in summer and winter so that they are always free from ice. If ventilation is poor in any areas, usually a dead end, an auxiliary or booster fan is installed and fresh air drawn from the main airway and forced through Vent-tube to the working face in the sub levels.

The large area of each sub level in the Negaunee mine permits most of the ore to be extracted by the regular system of sub level mining. Along the foot and under the hanging, however, it is sometimes necessary to vary the layout of the sub level as the pillars here are often larger and quite irregular in shape. In these cases the radial slicing system is used. Because of local conditions in certain parts of the mine a departure from the regular system of mining is being tried out. Four transfer areas have been developed that represent a modification of the usual scraper practice. A drift was driven on the transfer sub level from one of the regular two-compartment raises above a crosscut. Seven single compartment raises were put up from this drift at 35-ft. intervals and regular slicing started. The ore on the transfer subs is handled by a 25-hp. scraper hoist equipped with 48-in. box type scraper. Rails are laid in the bottom of this drift for the scraper to slide on and a ⅝-in. cast steel pull rope is used. The transfer drift is well lighted and one man operates the hoist. This system reduces development work on main levels in rock and permits the rapid extraction of the ore. As long as the area to be mined is free from water it has proven quite satisfactory; water, however, renders it impossible to avoid getting all of the ore wet, which increases the difficulty of loading at chutes, tramming and dumping, and also increases the moisture in the ore. Two of the transfer areas were developed under an area that was subject to heavy crushing and in which it was impossible to keep a two-compartment raise open long enough to mine a small area. Rapid mining in this area was a decided advantage as it reduced retimbering expense and here also the transfer systems have proven quite satisfactory as well as economical.

The hoisting equipment at this mine had an unusual feature that differs from the standard practice at the time of installation. An Ilgner flywheel set, purchased from the Westinghouse Electric



Steam shovel loading ore under steel trestle at the Negaunee Mine.

& Manufacturing Company, provides direct current for the skip and cage hoists, operated by a 450-hp. 2,200-volt a. c. motor. Both of the hoists were built by the Wellman-Seaver-Morgan Company. The skip hoist is direct connected with a 500-hp. 525-volt d. c. motor and has a rope speed of 1,500 ft. per minute; the cage hoist has a single geared reduction and is driven by a 200-hp. 200-volt d. c. motor with a rope speed of 1,000 ft. per minute. The Ilgner hoisting system was chosen in order to get more perfect control, reduce the peaks, and get higher efficiency. It had the distinction of being the largest Ilgner set in America for several years.

There are two air compressors, one a Nordberg tandem, two-stage, 2,090-cu. ft. capacity, driven by a 325-hp. Westinghouse synchronous motor, the other an Ingersoll-Rand, type P. R. E., two-stage, 2,400-cu. ft. capacity, driven by a General Electric synchronous motor.

The main pumping plant is located on the tenth level, 900 ft. below surface. The equipment consists of two Prescott, two stage pole pumps, 1,000 gallons 1,000-ft. head, with 300-hp. General Electric Synchronous motor, and an Alberger centrifugal seven-stage pump, 1,000 gallons, 1,000-ft. head, with 350-hp. General Electric motor. The Prescott pumps operate at a speed of 120 r. p. m., which is unusually high for a mine pump of this capacity. An auxiliary plant, on the eleventh level, pumps water 100 ft. to the tenth level. The equipment here consists of two Aldrich Pump Company vertical triplex 1,000 gallons, 200-ft. head with 75-hp. General Electric motors. A duplicate pumping station with larger sump has been excavated on the twelfth or bottom level, and within a short time one of the eleventh level pumps will be moved to the twelfth level and later on the second unit. They will pump directly to the tenth level, 200 ft. above. The tenth level sump has a total capacity of 390,000 gallons; that on the eleventh level 232,500 gallons, and that on the twelfth will, when finished, hold 285,000 gallons. Approximately 1,150 gallons per minute is pumped to surface from the tenth level.

Maas Mine

The Cleveland-Cliffs Iron Company holds the lease on the Maas mine and has operated the property since it was opened in 1902. The first shipments were made in 1907 and the total shipments to January 1, 1929, amounted to 4,170,025 tons. Production at the present time is on a basis of 400,000 tons per year; the total production to January 1, 1929, was 4,420,859 tons. The Maas mine is the main source of supply of ore of Bessemer grade among mines of the company. There is one vertical rectangular shaft 1,375 ft. in depth, built of steel and concrete. The upper 167 ft. is a massive reinforced concrete drop shaft firmly anchored into the ledge. The main haulage levels are 200 ft. apart and the ore body is developed and mined on the same system as the Negaunee mine. All the main levels at the Maas mine are connected to the main levels in the Negaunee mine for ventilation and safety.

The hoisting equipment consists of two 5-ton skips hung in balance, operated by a single reduction Lake Shore Engine Works hoist consisting of an 8-ft. diameter drum, hoisting speed 1,500 ft. per minute, driven by a 700-hp. Westinghouse motor. The cage hoist is a single reduction Lake Shore Engine Works hoist with a 10-ft. diameter drum driven by a 400-hp. General Electric motor. The compressor plant consists of two type P. R. E. two-stage Ingersoll-Rand compressors of 2,443 cu. ft. of free air per minute, each driven by 450-hp. Westinghouse synchronous motors. A General Electric motor generator set driven by a 215-hp. motor delivers direct current at 250 volts for the underground haulage system and electric scraper hoists.

The Maas mine is equipped with an auxiliary steam plant which can be put into service on short notice to furnish electric power for pumping at the company mines in case of an accident or a shortage of power from the hydro-electric plants of the Cliffs Power & Light Company. This installation consists of four 150-hp. Sterling boilers with Murphy mechanical stokers and a Parsons type, Allis-Chalmers turbine, direct connected to a 1,000-kw. Bullock type generator.

The main pumping plant is located on the third level with a sump of 218,000 gallons capacity. It is equipped with a Frescott 5¾-in. x 36-in. plunger pump of 800 gallons per minute capacity at 1,150

ft. head driven by a 325-hp. Westinghouse motor, and an Aldrich vertical Quintuplex plunger pump, size 7 in. x 12 in., of 600 gallons-per-minute capacity at 1,200-ft. head. About 1,000 gallons of water a minute is handled direct to surface, a distance of 1,100 ft. An Aldridge triplex pump on the fourth level relays water from this level to the third level sump.

At the present time most of the ore comes from the third and fourth levels. Preparations are under way to sink to the fifth level which will be opened 125 ft. below the fourth. It will take nearly two years to sink and fully develop the new level as 9,000 ft. of the rock and ore drifting will have to be done, after sinking the shaft 145 ft. The shaft is located back in the footwall in the hard quartzite that underlies the slates. Sinking must be done on the night shift so as not to interfere with the operations.

Athens Mine

The Athens mine is on property held under lease by the Athens Iron Mining Company and is operated by The Cleveland-Cliffs Iron Company which is a partner with Pickands, Mather Company in The Athens Company. It was opened in 1913 and shipments commenced five years later in 1918, and have been continued to date. A total of 3,150,410 tons have been produced up to January 1, 1929, of which 3,062,948 tons have been shipped.

It has one standard concrete vertical shaft 2,489 ft. deep and is developed on five levels. The upper 1,070 ft. is circular in shape while the lower 1,419 ft. is rectangular. It is equipped throughout with steel sets. The skip-cage road partition is 2-in. plank covered with gunite. It is connected to the Negaunee mine by a drift 1,100 ft. below surface. Owing to the depth at which mining was started, the development period was considerably longer than is usual for the Marquette Range.

The great depth of the deposit below surface, together with an overburden of 150 ft. of quicksand, presented an unusual problem in mining on the Marquette Range. Mr. S. R. Elliott, manager of the mining department of The Cleveland-Cliffs Iron Company, who was superintendent of the mine at that time, conceived the idea of starting at the bottom of the ore body and working upward, reversing the usual mining procedure. This innovation had many good features, among which was the strong probability of removing most of the ore before a cave came through to surface, which would decrease pumping and timbering expense and provide greater safety, dryer ore, etc. This method made it necessary to develop all of the lower levels of the mine before production started, which increased the time required and the expense of opening the property. The plan was to divide the ore body into blocks and to mine the lowest block first. A complete description of this method was published in the Transactions of A. I. of M. & M. Engineers in Volume 66. At the present time the first block has been mined and work is now under way in the second and third blocks. Most of the incoming water, amounting to 225 gallons per minute, comes in through the mined block, which was anticipated when the system was adopted. This has improved operating conditions, and has made it possible to use scrapers for handling all the ore now being mined.

The Athens ore is a soft hematite but is slightly different in structure from the Negaunee-Maas ore body as it is somewhat harder near the hanging but quite soft throughout most of the ore body. The ore has a tendency to swell when newly developed which makes it difficult to keep the drifts open. The jasper hanging caves readily, while both the slate and diorite footwall stand fairly well. Owing to the excessive pressures and the soft character of the ore, a rapid extraction is necessary on the sub levels to reduce retimbering.

The mine is now completely developed on the fourth, sixth, eighth and tenth levels as regards main level drifting although there will be a few additional crosscuts driven in the foot as successive blocks of ore are attacked. The main levels are at 200-ft. intervals and are connected by raises in the ore body. The ore is mined by the top slicing method with sub levels at 11-ft. intervals.

Ventilation is secured by a 40,000-cu. ft. multivane Sturtevant fan, driven by a 50-hp. motor located on the tenth or bottom level. The partition in the shaft between the cage road and skip roads was made airtight from top to bottom by the use of gunite. The cage and ladder roads are downcast while the skip roads are upcast. The air is forced upward through raises to the working places and is then discharged to the shaft on the fourth level by double ventilation doors. Air locks are provided on each level and many auxiliary doors are installed on the various sub levels to control the air movement. Auxiliary fans and vent tubes are used in the working places where necessary.

When the mine was first opened a considerable amount of water was encountered in developing the ore body, but for the last five years the amount handled has averaged approximately 225 gallons per minute. All water is diverted to the tenth level where there is a large pumphouse and sump. There are two horizontal duplex 5½-in. x 24-in. Prescott pumps of 500 gallons per minute capacity, each driven by 300-hp. synchronous motors, pumping 2,400 ft. in one lift direct to surface. This equipment was installed in 1918 and constituted the heaviest duty pumps installed in mines up to that time. The sump has a capacity of 235,000 gallons.

The shaft is equipped with two 7-ton skips in balance. The Imperial hoist has an 8-ft. drum and a rope speed of 1,783 ft. per minute, driven by a 900-hp. General Electric motor on 300 volts d. c. Direct current is furnished by a General Electric flywheel set generating 675 kw. by an 850-hp. motor. The cage hoist was manufactured by the Lake Shore Engine Works, has a rope speed of 940 ft. per minute, driven by a 400-hp. General Electric motor.

The compressor plant consists of a Nordberg of 2,090-ft. capacity and a two-stage tandem Ingersoll-Rand compressor with a capacity of 2,275 cu. ft. of air per minute.

Logging camp in winter. Land Department of The Cleveland-Cliffs Iron Company.

Open Pit Operations at the HILL-TRUMBULL MINE

By MAX H. BARBER *

Five million cubic yards of overburden removed and pit drained to develop this operation, which has produced large tonnage wash ore—Eighty-seven percent of ore shipped in 1928 was concentrates and thirteen percent direct shipping.

THE HILL-TRUMBULL mine, located just north of the village of Marble, Itasca County, Minn., consists of eight 40-acre tracts, five in the Hill and three in the Trumbull. The Hill property was a part of the Oliver Iron Mining Company's so-called Hill lease and in excess of 6,500,000 tons were shipped from the Hill forties prior to the surrender of the lease by the Oliver Company in 1916. The Trumbull property was not stripped by the Oliver Iron Mining Company.

The Mesaba-Cliffs Iron Mining Company, in which The Cleveland-Cliffs Iron Company is interested, took a lease on the Hill-Trumbull property February 10, 1919, and The Cleveland-Cliffs Iron Company has operated the mine for them steadily, starting shipments in 1920.

The Oliver Company treated some of the Hill ore in their Trout Lake washing plant, but the bulk of their production from this property consisted of direct shipping ore.

When The Mesaba-Cliffs Company took over the property it was necessary to extend the stripping limits on the Hill property and to begin stripping operations on the Trumbull. The grade of the wash ore varies somewhat, and it has been necessary to conduct our operations in such a manner as to obtain a uniform product; and this has required operating at several places in the pits at all times. On account of the nature of this operation, smaller type shovels have been used and the crews have been moved from one shovel to another as grading conditions required.

The Mesaba-Cliffs Company conducted stripping operations during the years 1919 and 1920 and then awarded a contract to the A. Guthrie Company in 1921. The contracting concern moved in excess of 5,000,000 cu. yds. of overburden during the years 1921 to 1925, inclusive, or at the rate of about 1,000,000 yds. per year. Practically all of the Trumbull ore body was uncovered by the contractor's stripping operation and the northerly limits of the Hill pit were extended, allowing the Mesaba-Cliffs Company to conduct mining activities to advantage, both from the standpoint of obtaining a desirable mixture in the ore shipped and in working out satisfactory track grades.

The approach into the Hill-Trumbull pits, crosses the East Trumbull forty and a corner of the West Hill forty.

All of the ore, with the exception of that supporting the tracks, will be mined with switch-backs and the operating grades will be limited to a maximum of 2½ percent. The present track leading into the Hill pit has a maximum grade of 1½ percent and that into the Trumbull pit 2½ percent. The deep ore in the pits will be mined with our 350-ton revolving Marion shovel, which will be several years in the future. By loading out the ore from 40 to 50 ft. above the digging level, the haulage tracks can be maintained on 2½ percent maximum grades. The ore tied up by the approach tracks will be taken out through an approach at the southwest corner of the Trumbull pit, or upon an inclined tramway, located near the present point of depression.

Stripping operations, which are now being carried on by the A. Guthrie Company at the east end of the Hill pit and by The Mesaba-Cliffs Company to the east of the approach tracks, will con-

* District Superintendent, The Cleveland-Cliffs Iron Company, Hibbing, Minn.

clude the stripping program at the Hill-Trumbull mine, unless future explorations demonstrate the existence of commercial ore. Present stripping operations will be completed during 1929.

The quartzite outcrops about one-half a mile to the north of the present pit limits. The Hill-Annex mine of the Jones & Laughlin Company lies to the east of the Hill pit and the Oliver Iron Mining Company control the properties to the south of the Hill and Trumbull pits. The Hill ore body is confined to three forties and the Trumbull to two, a small extension running over onto the West Trumbull forty. The depth of overburden is only 35 ft. at the west end of the Trumbull pit, where a second approach may later be provided, whereas the average depth over the property is 75 ft.

A washing plant was constructed in 1920 and the Mesaba-Cliffs Company shipped over 140,000 tons of concentrated ore during the latter part of that season. The total ore produced and shipments from the Hill-Trumbull mine by The Mesaba-Cliffs Iron Mining Company, through 1928, and the average analysis are shown at the foot of page 750.

"Paddy Shields," A. Guthrie & Company's 10-yd. Marion electric shovel, loading out stripping in the Hill pit

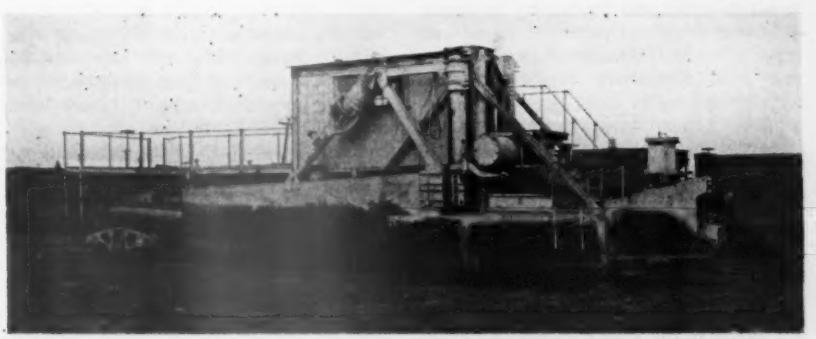
Model 88C Bucyrus steam shovel loading Trumbull wash ore into 30-cu. yd. Western air-dump cars. Train handled by 19 x 26 American locomotive

Some very low grade material has been washed and a large amount of rock has been sorted out in the pits and at the washing plant, but the character, as well as the analysis, of the ore shipped has been highly satisfactory.

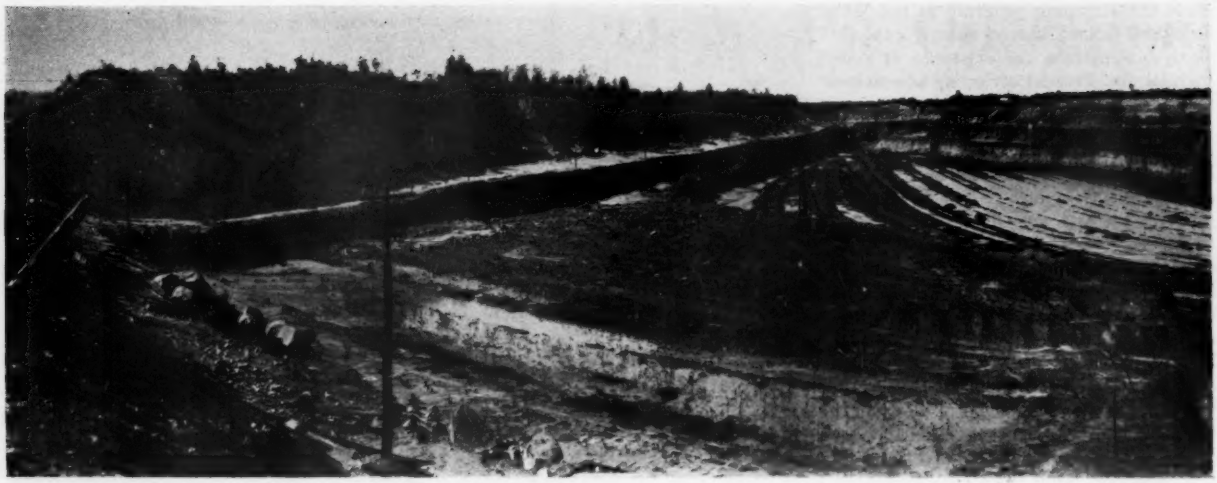
The gross tonnage recovery in the treatment of the wash ores has been 64.45 percent and the recovery of iron units 88.17 percent.

Of the ore shipped through 1928 by The Mesaba-Cliffs Company, 87 percent has been concentrates and 13 percent direct shipping. The grade of ore in future shipments will not average quite as high as those through 1928, but by careful mining and improvements in washing practice, the analysis should be maintained on a satisfactory basis.

At the time of taking over the Hill-Trumbull lease in 1919, the Hill pit was filled with water. The Mesaba-Cliffs Iron Mining Company's operations for the first few years were confined to ore banks above the water level. The water level was gradually lowered but in 1928 it was necessary to drain the pit water below the existing level. To accomplish this, a barrel scow, consisting of 49 empty steel oil barrels of 50-gallon capacity each, nested in a framework of 8-in. diameter poles was constructed and on this 18-ft. square scow was placed a size 6 type, 2-stage Allis-Chalmers centrifugal pump with 800 g. p. m. capacity against a 350-ft. head. The pump was driven by a 125-hp. Allis-Chalmers motor and was connected with a drainage ditch on the bank above by a 10-in. pipe, supplied with a swing-joint connection so that the water could rise 8 to 10 ft. with-



Jordan scraper plow, used for plowing dumps



General view of the Hill-Trumbull pit

The Hill-Trumbull Mine shortly after it was taken over by The Mesaba-Cliffs Iron Mining Company

out disturbing the pumping operation. This installation has worked very satisfactorily.

The pumping operations in the Hill pit had very little effect on the drainage of the Trumbull pit to the west of the approach. On account of the ultimate depth of the Trumbull workings it was not feasible to drift under the approach bench to drain the Trumbull. A Layne & Bowler deep-well pump, equipped with type L. K. M. U. head, 10-in. discharge and 8-in. Kingsbury thrust bearings, with a capacity of 1,000 g. p. m. against a 300-ft. head, was installed. This pump is driven by a 125-hp. Allis-Chalmers, 1,170 r. p. m., 2,200-volt, 3-phase, 60-cycle, vertical motor. The suction is located at the bottom of a well, 236 ft. deep, which reaches the lowest part of the ore body and drains the pit for approximately ¼ mile in each direction. The pump is located in the pit approach.

The ore in the Hill-Trumbull mine, especially the wash material, is quite dense and it is necessary to blast it for shovel digging. Vertical holes are put down, spaced from 20 to 30 ft. apart and the 30-ft. ore benches are thoroughly shaken. When there is considerable rock mixed with the ore, the holes are spaced a less distance apart and at times some block-holing is necessary to reduce the chunks for shovel handling. Two drilling machines are used, one a No. 14 Cyclone and the other a 4½-in. Keystone, electrically driven. The drill holes are put down to a depth of from 20 to 30 ft., depending upon the height of the ore bench to be blasted.

The general view of the Trumbull pit, taken from the approach track, shows the benches of ore, being cut back towards the northerly stripping limits. Since this view was taken in September, 1928, the Layne & Bowler pump has been installed and the water level in the ore around the pit lowered 50 ft.

A sinking cut, 25 ft. below the water level, as shown in the view, has been extended across the pit during 1929, and a third ore bench is now being worked. Three shovels have been operated in this pit during 1929 and two in the Hill pit. Two crews are employed steadily and at times a third is engaged. The crews are moved from one shovel to another, depending upon the grade of ore required. The Trumbull pit has been producing in excess of 500,000 tons of wash ore during the past several seasons, yielding in excess of 300,000 tons of concentrates. A small tonnage of direct shipping ore has also been mined. The dark-appearing material near the locomotive crane (shown in the illustration on this page), is the higher grade, or direct shipping ore area. The depth of overburden is shown clearly in this view, increasing from 35 ft. at the far end of the pit to 100 ft. opposite the shovel.

The deepest ore in the pit is located just beyond the approach, which would be in the foreground.

The daily output of concentrates is about 4,000 tons and the production of direct shipping ore varies from 1,000 to 2,000 tons, depending on our tonnage requirements and grades of ore.

The Hill-Trumbull mine shop buildings

Production	Tons	Iron	Phos.	Silica	Moist.	Iron (Natural)
Wash ore	4,636,237	43.56	.046	31.43	.....	.....
Shipments						
Concentrates	2,988,095	59.77	.058	7.46	7.50	55.29
Direct ore	448,971	59.06	.054	10.29	7.88	54.40
Total	3,437,066	59.68	.057	7.82	7.55	55.17

were erected in 1920 and are fully equipped to handle all of our repair work.

The shop equipment includes lathes that range in size from a 20-in. to a 48-in. swing, a 4-ft. Ryerson radial drill, a 24-in. Sibley sliding head drill machine, a 58-in. 200-ton Caldwell wheel press, a 24-in. Hollingworth back-geared shaper, a 2,000-lb. Niles-Bement-Pond steam hammer, a 300-ampere portable General Electric welder, a 20-in. Fay and Egan planer and joiner, a 16-in. rip and cut-off variety saw, also a Fay and Egan hand-saw with the necessary small tools for a complete machine, carpenter and blacksmith shop equipment.

A type "A" Jordan spreader plow is used in plowing the dumps. It is capable of spreading a dump shoulder 20 ft. from center of the track and plowing 24 in. below the track.

On page 749 is shown a view of the "Paddy Shields," a 10-yd. Marion electric shovel, operated by the contractors —A. Guthrie & Company—in removing surface material at the east end of the Hill pit. This machine was named in honor of A. Guthrie & Company's oldest shovel runner and is the largest shovel operating on the Mesaba Range. In the view the "Paddy Shields" is loading out track fills, the stripping bank 100 ft. in height being in the background. This 100-ft. bank was dug out with one lift.

The 88-C Bucyrus railroad type steam shovel is shown loading Trumbull wash ore into 30-cu. yd. Western air dump cars, the train of four cars being handled by a 19-in. x 26-in. American locomotive. The track leading from this pit has a maximum grade of 2½ percent and trains of four 30-yd. cars, shown by the views, or five 20-yd. Kilborne & Jacobs cars are used in the operation.

COOPERATIVE RESEARCH PROGRAM INAUGURATED BY IRON ALLOYS COMMITTEE

Dr. George B. Waterhouse, professor of metallurgy, Massachusetts Institute of Technology, will head an Iron Alloys Committee of the Engineering Foundation which, with the cooperation of industries, engineering societies, universities and the government, will inaugurate a program of cooperative research vital to the progress of the American iron and steel industry, whose future, it is said, will be affected by its ability to maintain a strong position in alloy irons and alloy steels.

The research, the initial stage of which will require five years and cost $150,000, will develop as an international enterprise, coordinating researches in ferrous metallurgy, the most important of which are going on in America, England and Germany.

Other members of the committee include Director Burgess of the U. S. Bureau of Standards; Director Turner of the Bureau of Mines; R. E. Kennedy, American Foundrymen's Association; Dr. Bradley Stoughton, director, Metallurgical Engineering Department, Lehigh University; Jerome Strauss, chief research engineer, Vanadium Corporation of America; T. H. Wickenden, metallurgical engineer, International Nickel Company; and Dr. John A. Mathews, vice president, Crucible Steel Company of America.

The Iron Alloys Committee will work in cooperation with the American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Electrical Engineers, American Iron and Steel Institute, Society of Automotive Engineers, American Society for Steel Treating, American Society for Testing Materials, U. S. Bureau of Standards, U. S. Bureau of Mines, numerous corporations in the metallurgical industries, and several universities.

"The subject of this Committee's work," an announcement says, "is basic data on iron and its very numerous combinations with other metals and certain metalloids. Our industries and engineers have scarcely more than begun to apprehend the possibilities of alloy irons and alloy steels.

"A great deal of information is being obtained in laboratories of industries, governmental bureaus, universities and other institutions in several countries.

"The Iron Alloys Committee consequently has accepted as its first duty the very large task of culling from the voluminous literature the essence of useful knowledge and putting it into forms convenient for use by researchers, technologists, engineers and superintendents. Repeatedly foremost technical leaders in the industries and research institutions have urged this work as the greatest possible aid which the Engineering Foundation, on behalf of the engineering societies, could give to the progress of the iron, steel and related industries in developing alloy irons and alloy steels.

"It is planned to print the results of this review of the literature in monographs and manuals.

"As the second part of its undertaking, the Iron Alloys Committee will aid, promote and organize researches for new basic information about pure iron and its combinations with other substances. It will not attempt to discover or devise commercial alloys; that is the business of the laboratories in the industries. Rather the Committee will seek those underlying facts which will be necessary to all the industrial metallurgical laboratories. To conduct this extensive and important project a committee of distinguished metallurgists has been selected from the several sectors of the field."

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BENEFICIATION of Hill-Trumbull Mine Ores

By
H. C. BOLTHOUSE*

Description of method used in beneficiating low-grade ores—Data covering a nine-year period of operation show average percentage of tonnage recovery 64.45 and average percentage of iron unit recovery 88.17—Crude ore treated in this period was approximately four and one-half million tons, which produced nearly three million tons of concentrates.

THE beneficiation of iron ore on the Western Mesaba Range in general, and at the Hill-Trumbull mine in particular, is accomplished by a process known as "washing." This treatment is necessary because most of the ore in the western district is not of sufficiently high grade for furnace use in its natural state. However, the ore is of such character that the undesirable siliceous material can be eliminated by "washing."

Before entering into an explanation or description of the methods used in treating the Western Mesaba ores, it is desirable that some understanding should be had of what distinguishes wash ore from standard grade or merchantable ore.

The iron formation on the Mesaba Range extends for a distance of 125 miles, having an approximate average width of about 2 miles. While the actual ore areas are of considerable extent, they occupy only a small percentage of the total area. Investigations have shown that almost the entire iron formation has been developed through a process of leaching of a hydraulic iron silicate known as "Greenalite" by the circulation of underground water. Where the process of leaching and subsequent enrichment was most effective, the result is the high-grade merchantable ore, but where conditions for the circulation of underground water were not so favorable, the process of enrichment was carried out to a lesser degree. These varying conditions produced iron formation grading from Greenalite, on the one hand, to high-grade ore on the other.

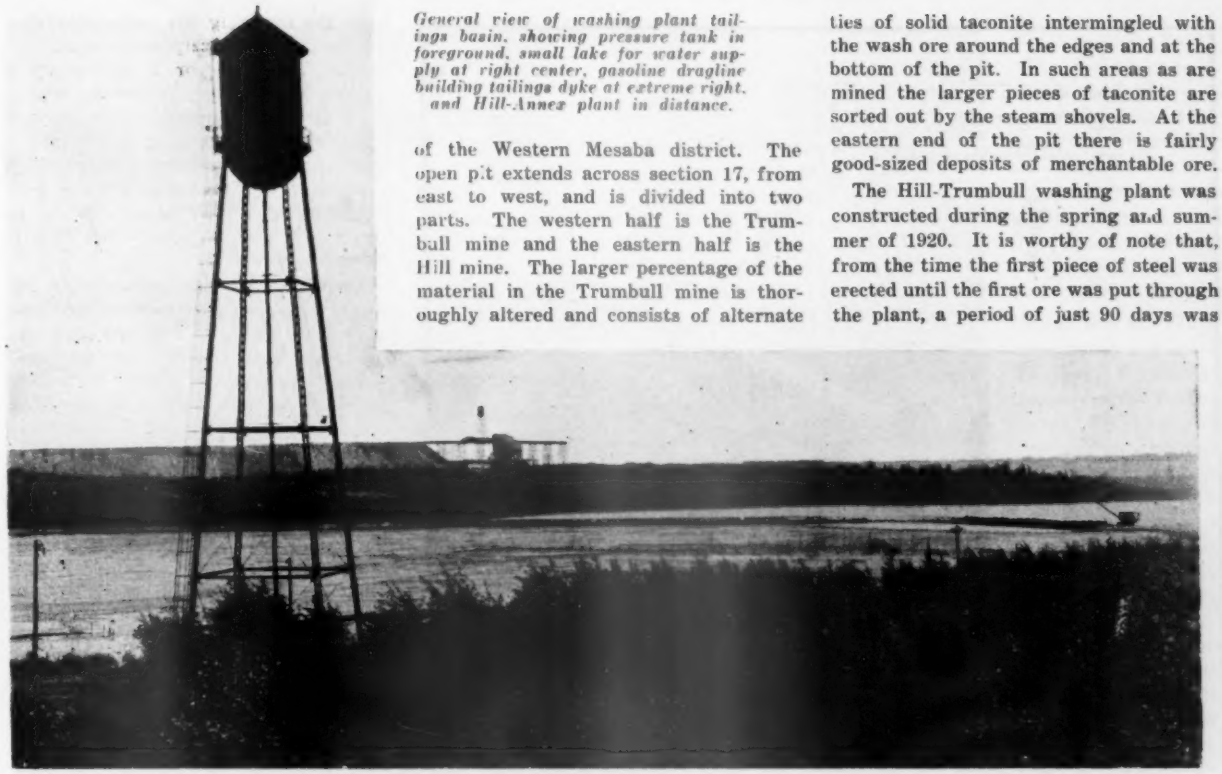
The degree of concentration affecting different areas naturally divide the Mesaba Range into three sections, viz. the eastern section, the central section, and the western section. In the eastern section there exists a hard, lean iron formation practically barren of merchantable deposits of any size, together with some lean siliceous material. In the central section are to be found merchantable ore bodies of large size, occurring in a rich, largely altered formation, together with a considerable amount of low-grade merchantable and non-merchantable siliceous ore material. In the western section the same altered iron formation occurs as in the central section and in it similar large ore areas; but here, instead of the merchantable ores, the non-merchantable siliceous ores predominate, together with solid and decomposed taconite. The non-merchantable siliceous ores of the Western Mesaba, together with some of the decomposed taconite and ore, are what constitute the wash ore bodies.

Typical wash-ore bodies are composed of alternating layers of high-grade ore and a very fine sand. The mass is easily broken up in mining, making a mixture of small chunks of hard ore and sand. The decomposed taconite and ore may or may not be washable; actual tests are generally necessary to determine its washability. The washable variety consists of chunks of fairly good ore with fine sand and considerable granular iron ore. The sand is not as free nor in as definite layers as in the typical wash ore, but the mass is a more homogeneous mixture of the ore and siliceous material, often with the sandy particles adhering to the ore.

One of the characteristic features of the Western Mesaba district is the occurrence in places of an unrelated layer of ore material, lying on top of the Mesaba ore formation. This layer is known as cretaceous ore, and consists of a coarse conglomerate of iron ore pebbles, grading upward through a finer conglomerate into a very fine black shale. The iron content is sometimes high enough to make it merchantable, but the lower grade material will not "wash." The name of this layer was derived from the fact that fossils of various kinds are found within it, and these have been determined to belong to the cretaceous age of geological history.

After the ore areas of the Western Mesaba had been explored and determined, the physical structure of the material suggested the possibility of making it merchantable through a process of concentration. The first experiments along these lines were conducted by Mr. Walter Barrows, Jr., Mr. Chas. A. Purdon and associates in 1901 and 1902, when they shipped a carload of ore from the Arcturus property, near Marble, Minn., to a concentrating plant at Cedartown, Ga. The results of this test were so satisfactory that a small concentrating plant, consisting of conical screens and McLanahan jigs, was installed at the Arcturus. Also, in 1903 and 1904, a small plant of somewhat similar construction, but with-

* Superintendent, Hill-Trumbull Mine, Mesaba Range, The Cleveland-Cliffs Iron Company.



General view of washing plant tailings basin, showing pressure tank in foreground, small lake for water supply at right center, gasoline dragline building tailings dyke at extreme right, and Hill-Annex plant in distance.

out jigs, was installed and operated at the property, which is now the Holman-Cliffs mine, by Mr. Congdon and associates. The results obtained at these two experimental plants demonstrated the possibility of concentrating the Western Mesaba ores. The tests also showed that the screens and jigs would not meet the requirements of commercial operations, because of the varieties of materials to be treated, and also on account of the large quantities to be handled.

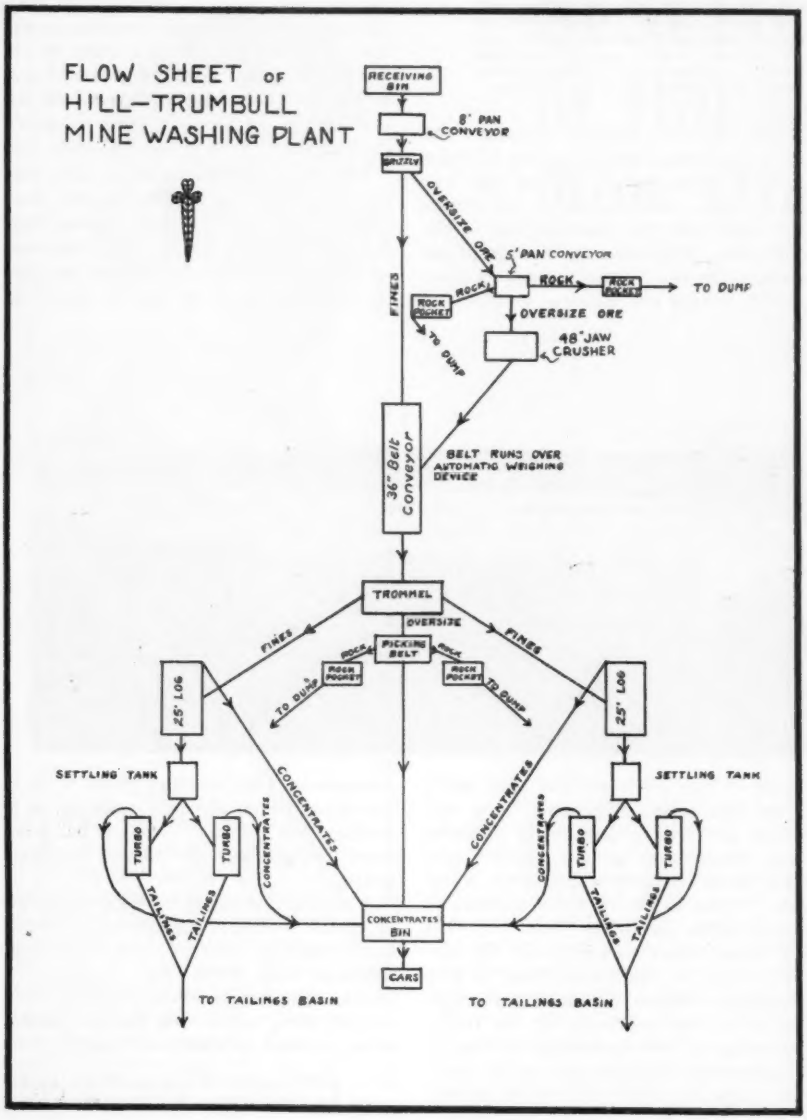
In 1905 the Oliver Iron Mining Company took up the investigation of the proper method for treating wash ores and, after considerable study and research work, erected an experimental plant in the vicinity of the Canisteo mine in 1906. During 1907 and 1908 experimental work was carried on in this plant with the machinery as originally planned, as well as with different concentrating machines which were suggested by manufacturers. As a result of these experiments, machines arranged in a series were designed and developed, which became standard for the Western Mesaba district. A standard five-unit washing plant was built by the Oliver Iron Mining Company, on Trout Lake, near Coleraine, Minn., in 1909 and 1910. During the last several years some departures from the original design have been introduced in the way of finer crushing and machines of the classifier type. Also jigging plants have been installed at several of the properties.

The Hill-Trumbull ore body is typical of the Western Mesaba district. The open pit extends across section 17, from east to west, and is divided into two parts. The western half is the Trumbull mine and the eastern half is the Hill mine. The larger percentage of the material in the Trumbull mine is thoroughly altered and consists of alternate layers of high-grade ore and sand, which is an ideal wash structure. This part of the pit also contains some taconite, some decomposed taconite and ore, and some sandy material which is not washable. There is also a small tonnage of merchantable ore in the Trumbull. The Hill mine, which was operated for several years by the Oliver Iron Mining Company, contains some high-grade sand and ore at the west end, but the larger percentage of the remaining ore body is a decomposed taconite and ore of washable structure. There are large quantities of solid taconite intermingled with the wash ore around the edges and at the bottom of the pit. In such areas as are mined the larger pieces of taconite are sorted out by the steam shovels. At the eastern end of the pit there is fairly good-sized deposits of merchantable ore.

The Hill-Trumbull washing plant was constructed during the spring and summer of 1920. It is worthy of note that, from the time the first piece of steel was erected until the first ore was put through the plant, a period of just 90 days was consumed. This washing plant is of a standard one-unit design, consisting of a feeding and crusher house, a belt-conveyor bridge, and the washer building proper.

A standard one-unit washing plant, as originally designed, consists of a revolving screen or trommel, two 25-ft. log washers, four 18-ft. log washers, or turbos, and 18 concentrating tables. The concentrating tables have become practically obsolete in wash-ore practice, and

Hill-Trumbull Washing Plant, showing crusher house and conveyor bridge.



in many plants the turbos and tables have been replaced by Dorr bowl classifiers. Also, during recent years, secondary crushing has been introduced into the cycle of washing operations. This crushing is applied to the oversize from the revolving screen, whereby the material is reduced to three-quarters or half-inch size, which results in the liberation of siliceous particles that adhere to the ore chunks. The product is then returned to the log washers. This treatment is largely applied to decomposed taconite and ore. The most recent development in the beneficiation of iron ore is the introduction of jigging units in connection with the washing plants. The jigs are used to concentrate a decomposed taconite and ore material, which is not treatable by the ordinary washing process.

In connection with all washing plants there are receiving bins into which the crude ore is dumped, and machines for feeding the ore to the mill as well as crusher to reduce the large chunks to a suitable size.

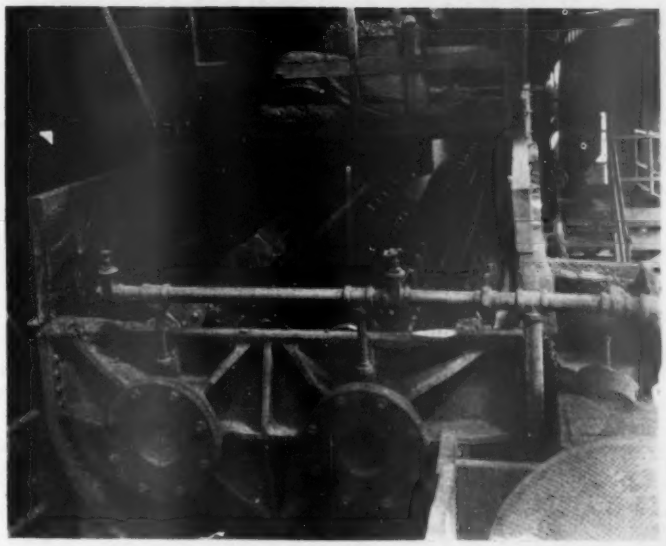
The Hill-Trumbull washing plant is located about 2 miles southeast of the mine. The wash ore is delivered at the mill in trains of five 20-cu.-yd. air-dump cars. The material is discharged from the cars into a concrete receiving bin of six-car, or 210 tons, capacity. A train is shown at the receiving bin in the view on page 756. A machine known as an 8-ft. pan conveyor, which is 8 ft. wide and 62 ft. long, extends back under the receiving bin and forms the floor of it. The belt of this machine, consisting of a series of steel plates, 1 ft. wide, joined together with hinges and pins in the shape of an endless chain, runs over rollers on an inclined plane, 20 degrees from the horizontal, carrying the ore from the receiving bin and discharging it onto a set of grizzly bars spaced 4 in. apart. The conveyor is driven by a variable speed motor, so that the feed to the mill can be regulated to a greater or lesser degree, depending on the quality of the ore being treated. When loaded to capacity, over its full length, the 8-ft. pan conveyor carries approximately 75 tons. This machine, with a full load, is shown on page 755.

When the material passes over the grizzly, the large chunks of ore and taconite are separated from the mass and delivered onto a horizontal 5-ft. pan conveyor, which acts as a picking belt. Here the pieces of taconite are removed by means of an air-operated ram and deposited in rock pockets, from which it is drawn off into cars and hauled to the rock dump by an electric locomotive. The large chunks of ore are carried to a 48-in. jaw crusher, where they are reduced to 3-in. size and delivered onto a 36-in. rubber belt conveyor, which also receives the fine material which has passed through the grizzly. The discharge end of the 8-ft. pan conveyor, the grizzly, the 5-ft. pan conveyor, the jaw crusher and the air-ram are shown in the illustration at the bottom of page 755.

The 36-in. conveyor is an endless rubber belt, 192 ft. long from center to center of the end pulleys, and supported by rollers set at regular intervals, rising on an inclination of 20 degrees from the horizontal. This conveyor carries the wash ore from the grizzly and crusher to the top of the washing plant and discharges it into a revolving screen or trommel. At a point about midway along the length of the belt an automatic weighing device is installed, which constantly records the tonnage of crude ore being delivered to the mill.

The revolving screen or trommel is an inclined cylinder, 12 ft. long and 6 ft. in diameter, the surface of which consists of three sections of perforated steel plates. The openings in the plates at the receiving end are 1 in. in diameter, those in the plates of the middle section are 1½ in. in diameter, while those in the plates of the discharge end are 2 in. in diameter. As the trommel revolves, the ore is tumbled about on the interior of the machine, gradually working its way down to the discharge end. As the ore advances through this screening device, jets of water are played upon it from a perforated pipe. This water loosens up and removes all of the free sand and other fine material from the larger chunks of ore, which are delivered onto a rubber picking belt at the lower end of the screen. As the oversize material is discharged onto the belt it is carried forward to a chute through which it runs to the concentrate bin. As the screen product is moved along toward

Conveyor to Crusher



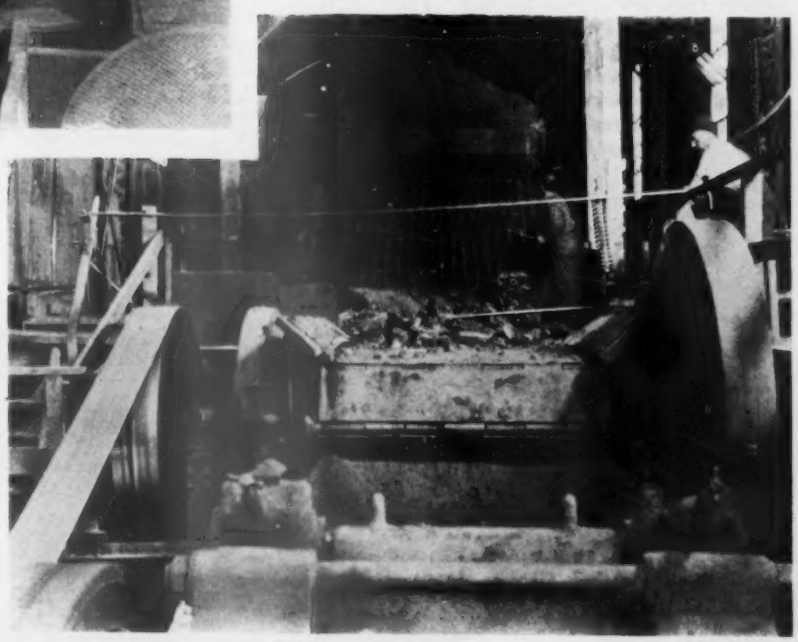
Looking into the tailings end of 25-foot log washer.

Right—Discharge end of 8-foot pan conveyor. Grizzly, 5-foot pan conveyor and 48-inch jaw crusher in foreground. The small shaft and disk in the center of the picture is an air ram used for handling large chunks of rock.

the chute, any taconite or other undesirable material is picked off by men stationed on either side of the belt. All such taconite and other waste substances are delivered to a rock pocket by means of chutes, from which it is drawn off into 3-ton cars and hauled to the rock dump.

The finer material, which passes through the openings in the screen, drops into a hopper underneath, from which it goes to a cushion box, where it is divided into two equal parts. The divided feed is sent through launders to two 25-ft. log washers, located on the right and left sides of the floor below the screen. The log washers consist of a steel trough 25 ft. long, with rounded bottom, set at an inclination of 1¼ in. to the foot. Within the trough are two shafts, running the full length of the machine and supported by bearings at either end. Set at 90 degrees from each other, around the shafts, are four rows of paddles, placed at regular intervals. These paddles are set at an angle, so that the four rows virtually form a broken spiral from one end of the shaft to the other. The two shafts are set at the proper distance apart, so that when the machine is in operation the paddles of one shaft overlap those of the other. The view to the left, looking into the tailings end of the 25-ft. log washer, shows the general construction of the machine and the arrangement of the paddles.

The ore, together with the water from the trommel, is fed into the log washers from above, a short distance back of the center of the machine. Additional water is introduced at both the head and tail ends. The paddles on the rotating shafts, which make about 15 r. p. m., keep the ore in constant agitation, while their spiral position continually forces the coarser material up the incline toward the head end. The



large quantity of water flowing down the incline, through the mass, carries off the fine sand and finer ore, over the tail board, and this product is conducted to settling tanks by launders. The coarse concentrated ore is discharged from the logs at the head end and goes through chutes directly to the concentrate bin.

The overflow from the logs, after going through the settling tanks, is divided into four equal parts and then fed through launders to four 18-ft. log washers or turbos. These machines are constructed and operated practically the same as the 25-ft. log washers, the difference being that the paddle shafts make about 8 r. p. m. and hydraulic water is introduced through six hutches in the bottom. The coarser material is discharged at the head-end as concentrates and goes directly to the shipping ore bin. The fine material, which is now mostly sand and carrying very low iron value, is considered as waste and discharged through launders into the tailings basin.

As the washing plant was originally designed, it was intended that the overflow from the turbos should go to 18 concentrating tables for further treatment. It was found, however, that the quantity of material recovered on these machines was so small, and the grade of the product so poor, that it was not economical to operate them.

The tailings basin is a tract of low swamp land, approximately 3,500 ft. long and 1,000 ft. wide, lying between the washing plant on the west side and Little Penacie Lake on the east side. This area is not a naturally inclosed basin, therefore it has been necessary to cast a dike along the north, east, south and part of the west sides in order to prevent the tailings from flowing into the lake. The water within the basin is controlled by overflow pipes, which discharge into the lake. The intake ends of these pipes are adjustable as to height, so that the depth of water may be regulated, and the tailings allowed to settle down before the water flows off. The dike is constructed from the tailings after the water has drained out. This work is accomplished by means of a gasoline-driven dragline, which digs up the material from the floor of the basin and casts it up to form a bank. A view on page 753 shows the pressure tank at the washing plant in the foreground, the tailings basin in the center, Little Penacie Lake at the right center, the gasoline dragline on the dike at the extreme right, and the Hill-Annex washing plant of the Jones & Laughlin Company in the distance.

The water supply for the washing operations is provided by a pumping plant, which is located near the south end of the tailings basin. The equipment consists of one 2,000-gal., electrically-driven Worthington pole pump and one 2,000-gal. electrically-driven centrifugal pump as an auxiliary. The water is pumped out of Little Fenacie Lake and is delivered to the washing plant through a 20-in. spiral-riveted pipe line.

From time to time, as experience dictated, labor-saving devices have been introduced. The interior of the receiving bin was redesigned to eliminate square corners. The crude ore had a tendency to hang up and required poking to make it run. By rounding the corners this difficulty was overcome and the labor of two men was dispensed with. Large quantities of rock are removed from the ore as it passes over the 5-ft. pan conveyor and this work originally required two extra men. An air-operated ram was installed, at the side of the conveyor, which pushes and pulls the rock chunks off into pockets, with a subsequent saving in labor.

During the first several years operation of the washing plant the railroad cars, which transport the concentrates, were moved under the chutes by means of pinch bars, and controlled by means of hand-brakes. At the present time the cars are moved by an electric vertical drum winch, and controlled by compressed air, conveyed to the brake cylinders through a rubber hose. The brakes are operated by a straight air valve located on the loading platform at the concentrate bin. These installations again saved the labor of two men.

The results obtained at the Hill-Trumbull washing plant are best shown by the tables below, which covers a period of nine years' operation.

While there are constant changes taking place in the methods and machines used in concentrating the low-grade ore of the Western Mesaba district, none of these have been introduced into the Hill-Trumbull washing plant. Tests have been made to determine the advisability of making changes, but the ore in the Hill-Trumbull mine is of such character that the method and machines in present use have been proven to give as satisfactory results as any of the new devices.

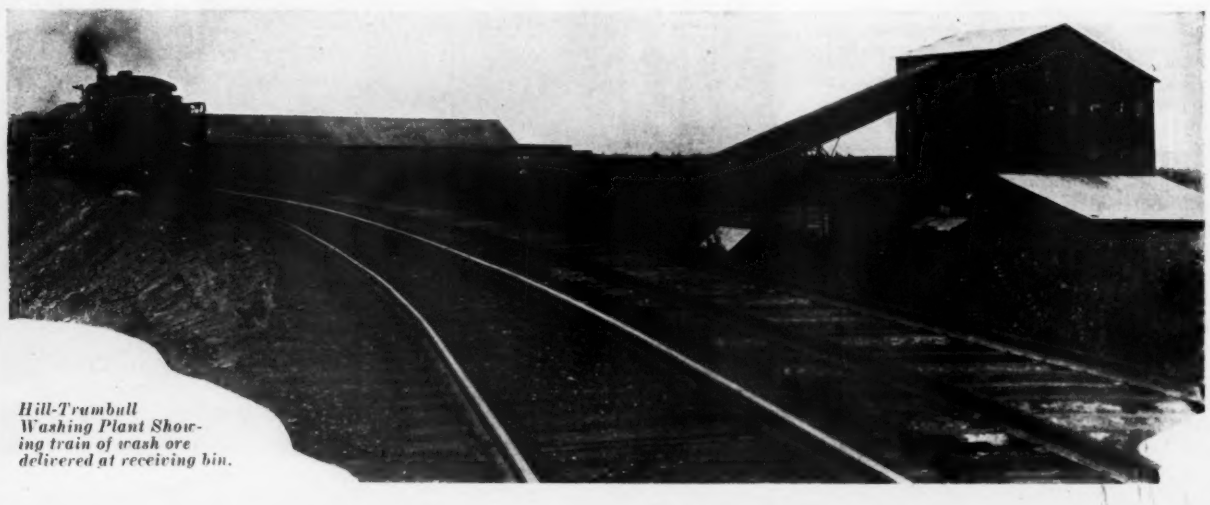
Average Analysis of the Products from the Various Machines in Producing 2,988,095 Tons of Concentrates

Machine	Average analysis Iron	Phos.	Silica
Screen	59.39	.060	7.66
Logs	59.82	.058	7.36
Turbos	55.01	.050	15.35
Tables*	50.39	.040	23.16
Tailings	15.75	....	.....

* The tables were operated only during the production of 1,024,104 tons of concentrates.

The flow sheet showing the cycle of operations in the mill is shown on page —.

	Total tons	Average analysis Iron	Phos.	Silicia
Crude ore treated	4,636,237	43.70	.046	31.30
Concentrates produced	2,988,095	59.78	.059	7.46
Average percentage of tonnage recovery				64.45
Average percentage of iron unit recovery				88.17



Hill-Trumbull Washing Plant Showing train of wash ore delivered at receiving bin.

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TILDEN OPEN PIT on the Marquette Range

By G. R. JACKSON *

New silicious iron ore pit opened in 1929, with production of over four hundred thousand tons for shipping season—Stripping done by hydraulic power—Flow sheet of crushing plant

THE TILDEN is a new silicious iron ore pit which began on an operating basis during the present year. It is owned in fee by the company, being on lands which originally belonged to the Iron Cliffs Company but which were transferred to The Cleveland-Cliffs Iron Company when the latter was organized.

The mine is three miles south of Ishpeming and is reached by automobile from the beautiful Cliffs Drive. It adjoins the Foster mine formerly worked by the company, but which was abandoned about 30 years ago.

The existence of this ore body has been known for a great many years. It is exposed on the south side of a hill which rises to a height of 180 ft. above the swamp level. The ore has an ideal physical structure, and is a hard silicious hematite, being very low in all impurities and moisture. It was tested in 1927 by diamond drilling for analysis which proved it to be a most desirable product.

The ore occurs in the upper Negaunee Formation of the Middle Huronian Period. It is bounded on two sides by intrusive diorite of a later age. The iron formation has a northerly dip of from 50° to 80° and the Siamo slate footwall is a considerable distance to the south.

Much of the ore formation is overlain by sand and boulders, varying in depth from 2 to 6 ft.

The analysis of the deposit as shown by diamond drilling runs as follows:

	Analysis dried at 212°
Iron	41.50
Phosphorus	.043
Silica	36.50
Manganese	.12
Sulphur	.012
Alumina	.67
Lime	.48
Mangnesia	.31
Lost by ignition	.90

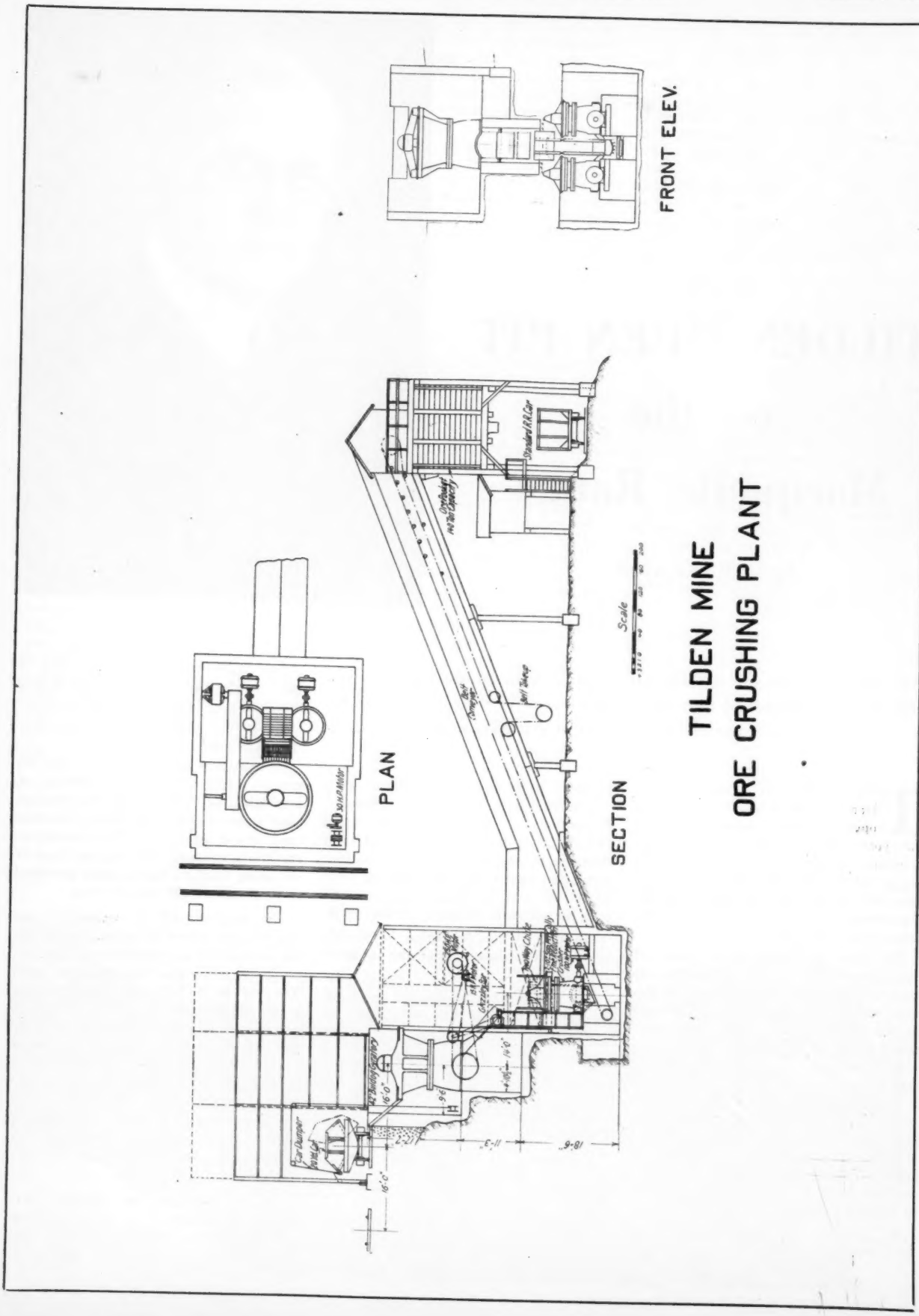
This year's product to the middle of July, checks the foregoing very closely but averaging slightly higher in silica. The moisture content to date has averaged 3 percent.

Preparations to open the pit were begun in 1928. The Lake Superior & Ishpeming Railroad, during the summer, built a spur from the North Western track to the mine site. The elevation of the track opposite the exposed face of ore being 1,440 ft. above mean sea level or 20 ft. above the swamp level.

The property will be worked in two benches, the upper of which is now being opened at an elevation of 1,490 ft. or 50 ft. above the main railroad spur. The crest of the hill which rises abruptly to the north is 80 ft. above this bench and then gradually ascends 20 to 30 ft. higher. A standard gauge railroad track provides connection from the present operating bench on level tracks to the crusher 600 ft. east. Practically all of the power used, with the exception of that of the locomotives, is electric. It is bought from the Cliffs Power & Light Company.

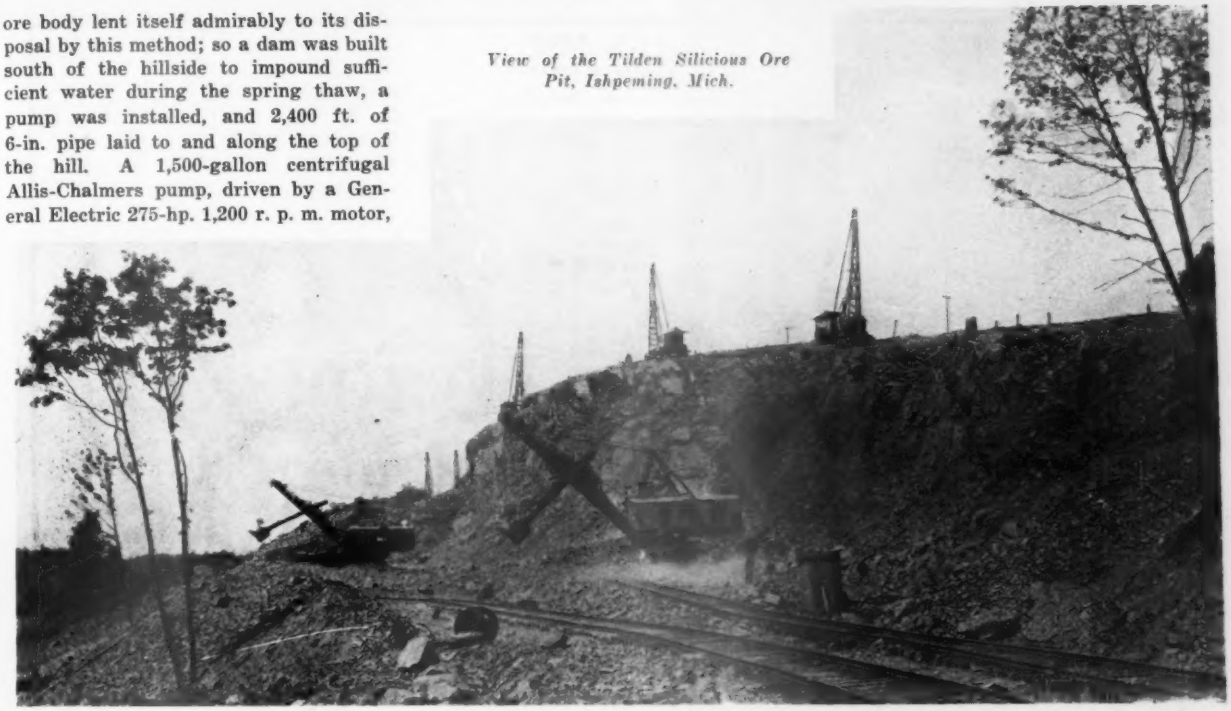
The stripping of the shallow overburden was started in May, 1928, by hydraulic power. The topography of the

* General Superintendent, The Cleveland-Cliffs Iron Company.


FRONT ELEV.
PLAN
SECTION
Scale
TILDEN MINE
ORE CRUSHING PLANT

ore body lent itself admirably to its disposal by this method; so a dam was built south of the hillside to impound sufficient water during the spring thaw, a pump was installed, and 2,400 ft. of 6-in. pipe laid to and along the top of the hill. A 1,500-gallon centrifugal Allis-Chalmers pump, driven by a General Electric 275-hp. 1,200 r. p. m. motor,

View of the Tilden Silicious Ore Pit, Ishpeming, Mich.

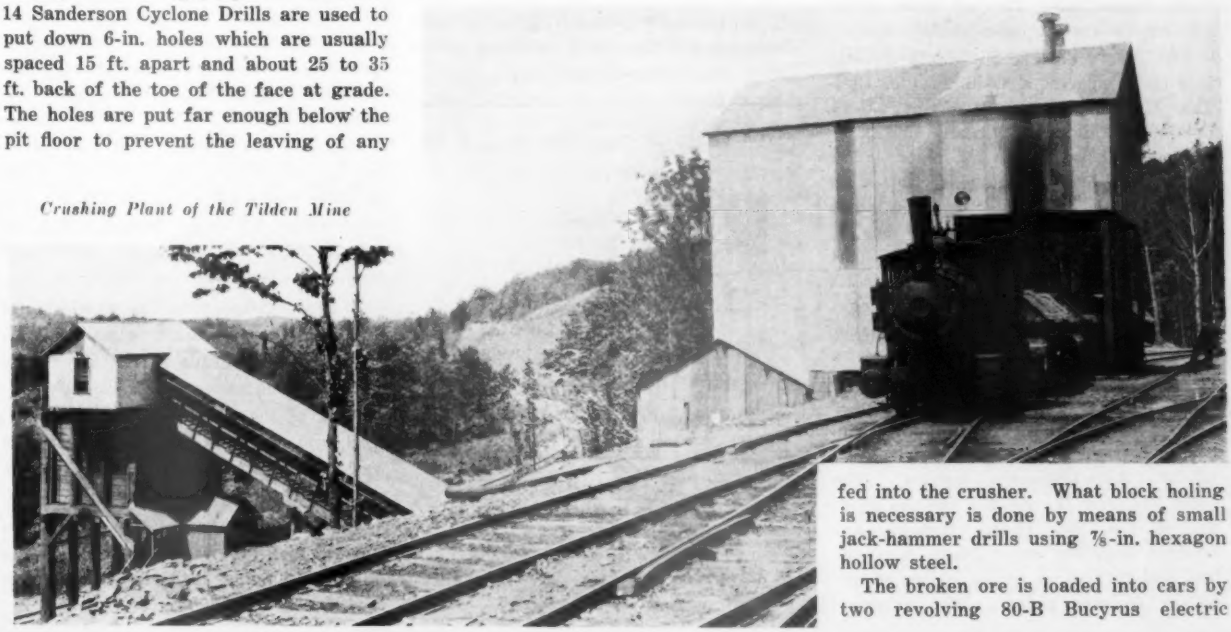


delivers 100 lbs. pressure at the nozzle to each of two monitors on swivel supports and in this way from 4,000 to 5,000 cu. yds. of stripping have been washed off the pit area each month during the summer. The water returns to the dam below the hill and is used over and over again.

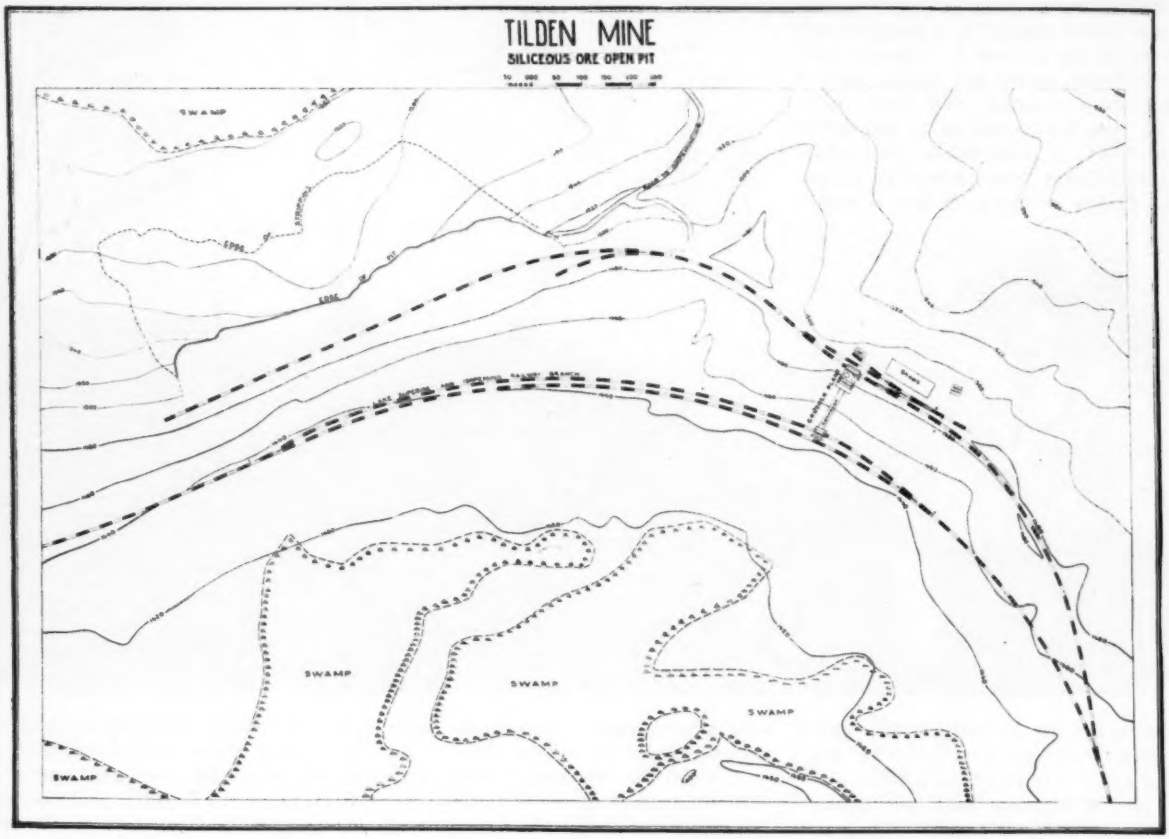
The ore is hard and tough, and as the face will eventually be 100 ft. or higher, churn drills were selected as the safest and best means of accomplishing the drilling for blasting purposes. Five No. 14 Sanderson Cyclone Drills are used to put down 6-in. holes which are usually spaced 15 ft. apart and about 25 to 35 ft. back of the toe of the face at grade. The holes are put far enough below the pit floor to prevent the leaving of any solid ground either between the holes or at the toe of the vertical face, at the floor elevation. Blasting is done with 17-lb. cartridges of gelatin dynamite. The amount of charge for each hole of 80, 60 and 40 percent dynamite necessary to break the burden is carefully calculated, from measurements taken in the field, before each blast. Unless the holes contain water, which makes the use of tamping unnecessary, about 10 ft. of damp sand is used in each hole. Complete records of each blast are kept and from them it has been found that one pound of powder shatters from 35 to 45 cu. ft. of ore in place, and for every foot of hole blasted, there results from 25 to 35 tons of ore.

The powder in each hole is connected and detonated by Cordeau-Bickford fuse, and the largest blast at the pit thus far consisted of 85 holes which broke nearly 100,000 tons of ore. Most of the ore breaks into chunks which can be readily fed into the crusher. What block holing is necessary is done by means of small jack-hammer drills using ⅞-in. hexagon hollow steel.

Crushing Plant of the Tilden Mine



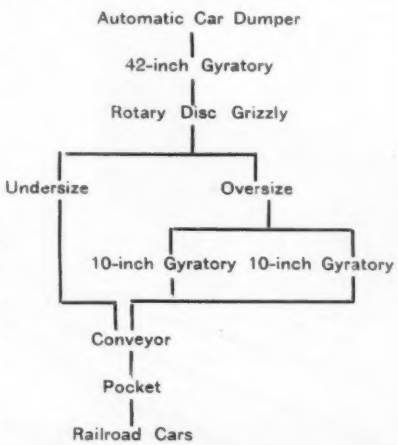
The broken ore is loaded into cars by two revolving 80-B Bucyrus electric



shovels, equipped with 2½-yd. dippers, the current being delivered at 2,300 volts. It is transported to the crusher in trains of three cars by steam locomotives. The cars are all steel, standard gauge, of the Phoenix Duplex type, and have a capacity of 10 cu. yds. for each body, there being two of these or 20 yds. on each steel railroad flat car.

The cars from the pit dump directly into the hopper of a 42-in. Traylor Bull-Dog Gyratory Crusher set at 5½-in. opening. This is electrically driven by a General Electric 275 hp. motor. The dumping of each car body is effected by an arm raised by an electric hoist which engages the body, lifts and dumps it, the car body then is lowered to the chassis and the dump arm returns to its place out of the way to await the next car. The product from the 42-in. crusher passes over a rotary disc grizzly 34 in. in diameter set at 1½ in. openings and the oversize goes to two 10-in. Superior Fine Reduction Crushers set to 2 in. Each of these is electrically driven by 100-hp. Allis-Chalmers motors. The undersize from the grizzly and the product of the two 10-in. crushers, are brought together on a 36-in. conveyor belt and carried up on an incline of 22° to the railroad pocket. The conveyor belt is driven by a 75-hp. Allis-Chalmers motor and has a speed of 400 ft. per minute which gives the plant a capacity of 400 tons per hour. The distance between the top and bottom conveyor pulleys is 116 ft. The railroad pocket is of timber construction and is 15 x 18 x 14 in size, holding about 190 tons of which 160 tons are effective. It is bottom discharging, through hand operated gates, direct into railroad cars.

FLOW SHEET OF THE CRUSHING PLANT



Under one roof has been constructed a blacksmith shop, carpenter shop, warehouse, compressor plant, sub-station, change house for men and the office.

The change house at one end of the building provides accommodation for 75 men. Adjoining this are the carpenter and blacksmith shops, the latter containing two forges and an Armstrong bit dressing machine for the churn drill bits and an Ingersoll-Rand sharpener for small drill steel. Next to the change house, the compressor and sub-station are housed, and at the other end of the building is the office and warehouse. The compressor, a Laidlaw-Dunn-Gordon, has a capacity of 800 cu. ft. per minute and is electrically driven.

A short distance to the southeast of the crushed ore pocket, a switch back on a 3 percent grade connects with the tracks on the upper bench elevation.

Work at the mine was started May 1, 1928, and one year later the production was at the rate of 400,000 tons for the shipping season.

The pit being near Ishpeming, no housing facilities were necessary for the men, they being transported to and from work by motor trucks.

By
H. R. HARRIS *

TRANSPORTING ORE from Mine to Docks

From a railroad known as "The Plank Road" in 1854, consisting of 4-wheel cars of 3 ton capacity, pulled by mules, the Lake Superior & Ishpeming road is now classified as a Class 1 railroad, with 32 locomotives and 1,883 freight cars.

IT WAS not a new idea that caused The Cleveland-Cliffs Iron Company to become interested in constructing and operating a railroad for transporting iron ore from the mines of the Marquette Range to Lake Superior, for the Cleveland Iron Mining Company, organized in 1850 and which was the first incorporation of The Cleveland-Cliffs Iron Company, joined with the Jackson Iron Company in 1854 in building and operating a railroad from Ishpeming to Marquette, a distance of 15 miles, known as "The Plank Road"; this, in reality, consisted of cross sleepers on which were laid longitudinal stringers covered with strap rails; over this road 4-wheel cars of 3 tons capacity were pulled by mules, making one round trip totalling 30 miles a day. This road was operated for two years, until 1857, when the Iron Mountain Railroad was built parallel to it for steam transportation and mule haulage was abandoned.

The Lake Superior & Ispheming Railroad Company as it now exists, is classified by the Interstate Commerce Commission as a Class 1 railroad, although it has but 164 miles of main line and branches; it is a merger of three railroads, the Lake Superior & Ishpeming Railway, Munising Railway and Marquette & Southeastern Railway, which were separate corporations, each with separate ownership and constructed for different purposes but connected and operated jointly and were controlled by The Cleveland-Cliffs Iron Company.

It is interesting chiefly because of the nature and volume of the freight traffic, particularly iron ore, from the mines of the Marquette Range for shipment by vessel from Marquette to lower lake ports, and the development of a timber territory and industries to use that timber.

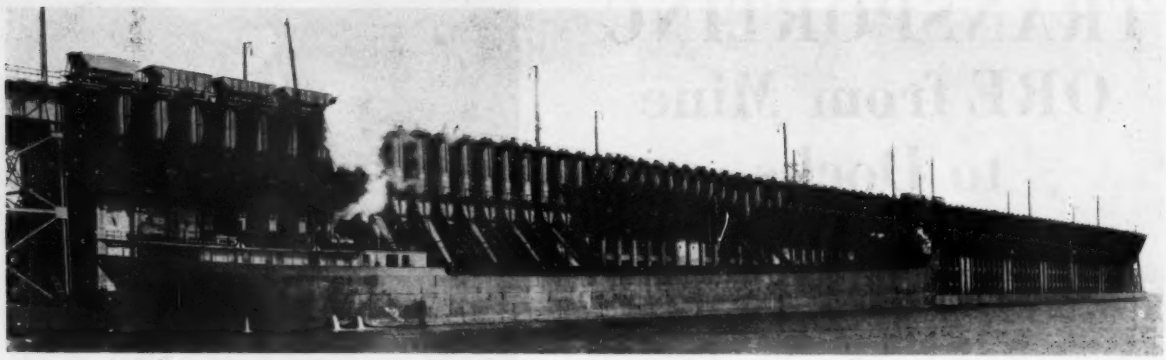
The Lake Superior & Ishpeming Railway was projected by The Cleveland-Cliffs Iron Company and the Pittsburgh & Lake Angeline Iron Company from Presque Isle harbor in North Marquette to Ishpeming, a distance of 20 miles. The first shipment of ore was made in the fall of 1896, with total shipments that year of 290,000 tons; in 1897 the first full year's operations, 1,036,000 tons were shipped. Equipment at the start consisted of 14 locomotives, 4 of them for road use, 400 wooden ore cars, center dump of 60,000 lbs. capacity and 24 miscellaneous cars. The road locomotives were of the compound consolidation type having a tractive effort of about 26,000 lbs. and the cars and locomotives were modern and of about the maximum capacity for that day; a train consisted of thirty 30-ton cars or a total revenue load of 900 tons.

The ore dock was of wood of the latest type of construction for that period, 54 ft. high, 1,200 ft. long, with 200 pockets each holding 160 tons or a total storage of 32,000 tons.

The main line was 20 miles long with 9 miles of sidings, 7 miles of leased road, making a total of 36 miles.

The demand for iron ore commenced to increase in 1897 and the development of mining and transportation of iron ore for several years was rapid, requiring extensions of tracks to new mines and

* Vice-President and General Manager, Lake Superior & Ishpeming Railroad Co.



At top—Marquette Harbor in 1863, showing type of vessels carrying 300 to 400 tons.

Below—Steamer J. H. Sheadle loading ore at Lake Superior & Ishpeming Railroad concrete ore dock. This dock was built in 1912.

an increased number and size of locomotives and cars.

In 1898 40 steel ore cars of 50 tons capacity, followed by 50 similar cars in 1899 were purchased from the Schoen Pressed Steel Car Company, the predecessors of the Pressed Steel Car Company; these were the first steel cars used in ore dock service and by the way, are still in use although they are now classed as 40 tons instead of 50 tons capacity; thereafter none but steel ore cars were purchased.

In 1911 the wooden ore dock built in 1896 had become obsolete, and as further repairs were unwise it was arranged to build a new dock which was completed in 1912. This was built of steel and concrete, 1,200 ft. long and 54 ft. wide, the deck being 75 ft. above the water. It contains 200 pockets, 12 ft. centers, with a capacity of 250 tons each or a total storage capacity of 50,000 tons, with two door openings of 3 ft. 8 in. each or a total clear opening of 7 ft. 4 in. The hinge hole of the spouts is 43 ft. above the water; the framework of the spouts is 35 ft. long, but an extension of the spout lining 3 ft. in length makes 38 ft. of spout available, and the spout can be further lengthened by extension of the lining if necessary for wider vessels. The foundation consists of a sufficient number of wooden piles to sustain the weight of the structure, and these piles are enclosed by 12-in. timber sheet plank wall, which is cut off 6 in. below the low water level, and filled with sand, with the intention of making the foundations everlasting. The dock proper is a concrete structure reinforced with a self-supporting steel framework which adds to its rigidity. The fronts of the pockets are semi-circular in form, of rolled steel plate. The chutes, 8 ft. 4 in. wide at the dock front, narrowing to 4 ft. 9 in. at the outer end, are operated by means of 10-hp. electric motors, each motor operating 6 chutes by means of a line shaft.

The old wooden ore dock, built in 1896

The approach to the dock is about one mile long on a 1½ percent grade and consists of an earth embankment containing 600,000 cu. yds. of earth connecting with about 600 ft. of 4-track steel trestle, which connects the embankment with the dock.

In adopting a design for a structure such as a concrete ore dock, having a long life, it was necessary to give careful consideration to future size of lake ships and to labor-saving devices so that the fullest savings in dock costs and

dispatch in loading vessels could be secured; the length and depth of vessels presents no difficulties in loading—that problem is in the width.

When the concrete dock was built the maximum width of vessels was 60 ft; it has now reached 70 ft. in a few built in the last two years but the height of the spout hinge hole above the water, the length and width of spouts and the width of dock door openings adopted, all join in giving the economy and efficiency desired; there is no fear of any difficulty in loading vessels of 70 ft. or even 75 ft. in width if with free running ore.

The annual shipping capacity of the dock has been considered as 3,000,000 tons but this year will probably reach 3,300,000 tons. Navigation, depending upon the ice conditions in the Great Lakes and rivers, is ordinarily open from May 1 to December 1, but mild conditions, such as in 1929, permit it to open about the middle of April and the closing in any year may be extended as late as December 10 if necessary to complete the shipments.

The actual loading time of vessels in tons per hour in 1928 was 1,876 tons compared with 675 tons in 1899, the first year in which permanent records were kept.

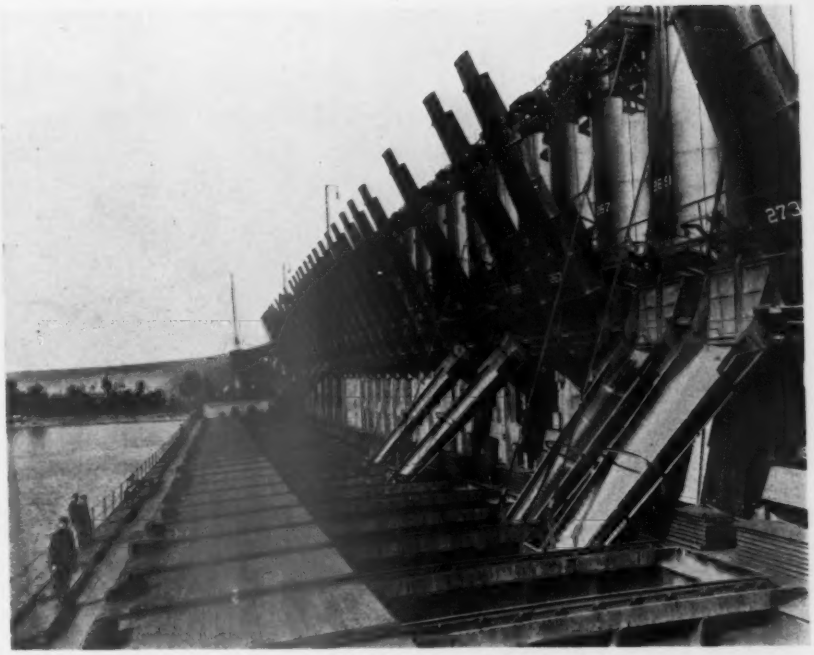
The average dispatch of vessels per 1,000 tons between arriving and completing loading over the entire season and including delays of all kinds was 54 minutes in 1928 compared with 296 minutes in 1899.

The average tons for each vessel loaded was 9,273 in 1928 compared with 2,431 in 1899.

The total tons shipped over the dock from 1896 and including what is expected in 1929 is 59,593,311, and in addition 3,980,000 tons of all rail ore have been handled.

Only a small part of the ore from the Marquette Range is mined from open pits; it is mostly from shaft mines which operate the full year and during closed navigation is put into stockpiles and then loaded by steam shovels during navigation; then the output of the mine is loaded direct into cars for transporting to the dock.

The mines attempt to complete shipments before freezing weather but are seldom successful; soft ore contains moisture of about 10 percent; the temperature frequently reaches 10 degrees above zero, as early as November 10, and when frozen the ore must then be thawed both in cars and dock, either by steam or hot water through the ore or in a house built for that purpose storing 26 cars, heated by steam pipes to a temperature of about 120 degrees, which usually thaws the ore in eight hours; the frozen ore, therefore, causes much expense as well as delay to the vessels.

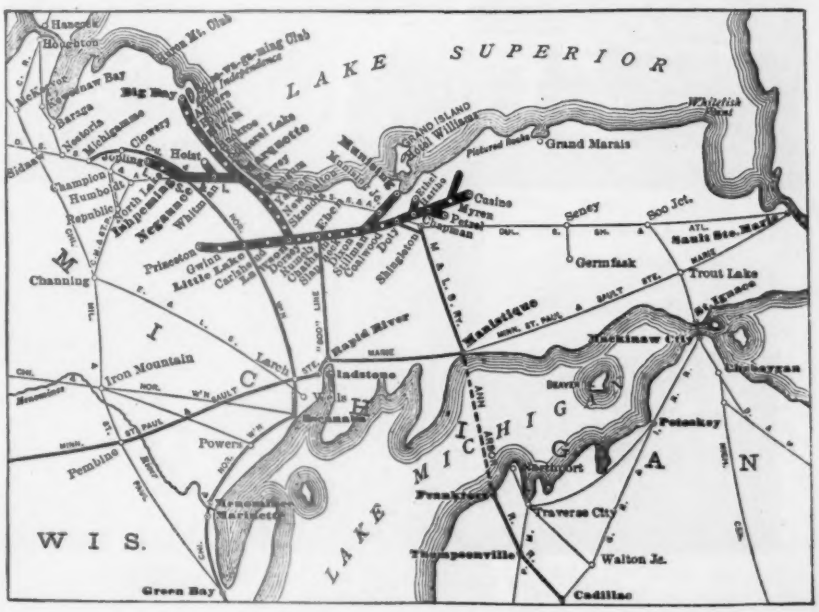


Concrete dock front, from an ore boat, showing chutes.

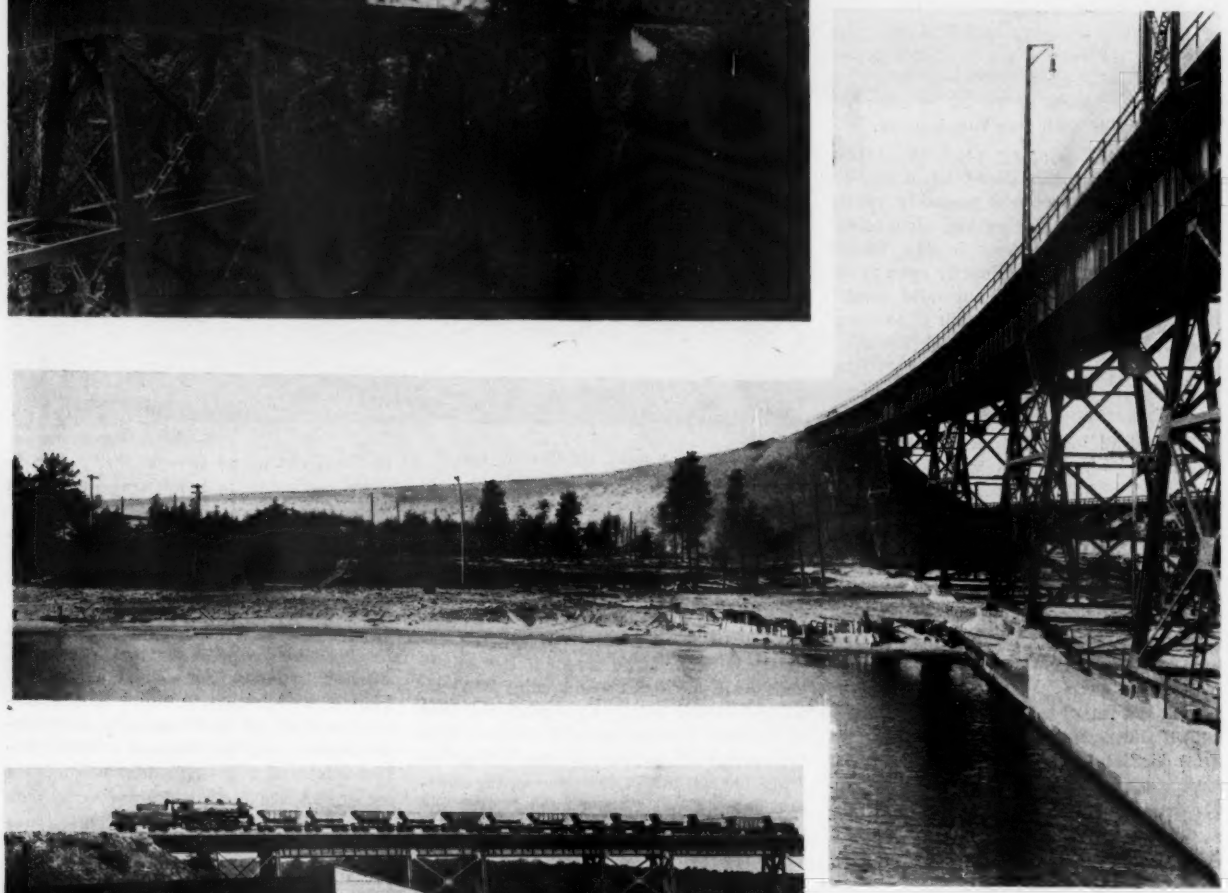
The ore cars which are standard for ore dock practice are 22 ft. in length, 24 ft. centers. This corresponds with dock pockets 12 ft. in width which in turn correspond with hatches in the vessels spaced 12 ft. between centers; the capacity is rated at 50 tons but the American Railway Association rules and the weight of the empty cars permit a load of 134,000 pounds; a cubic foot of iron ore varies in weight, a car containing from 100,000 to 134,000 pounds, the average being about 108,000 pounds; for the proper mixing of ore, which is now so necessary, the present capacity car is more desirable rather than the 75-ton capacity car.

The size of trains is fixed by westbound grades from dock to the mines, which is 1.63 percent, the longest grade being 8 miles. The westbound train consists of sixty 50-ton empty cars, hauled by locomotives with a total weight of 270,000 pounds, on drivers 240,000 pounds, and a tractive effort of the locomotive itself of 56,000 pounds, plus tender booster 11,200 pounds or a total tractive effort of 67,200 pounds, an increase

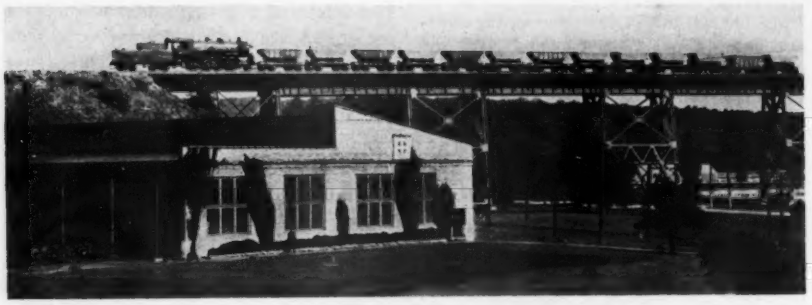
Map of the Lake Superior & Ishpeming Railroad and connections



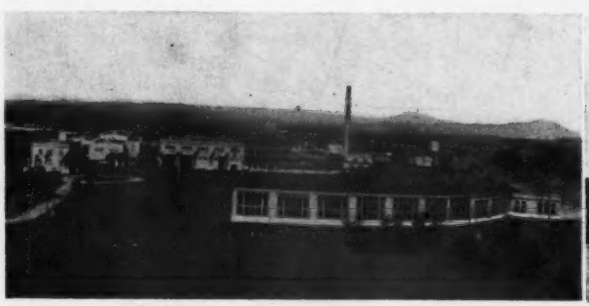
Left—Ore train crossing Dead River bridge. Tender booster, with cylinder cocks open, is in operation.



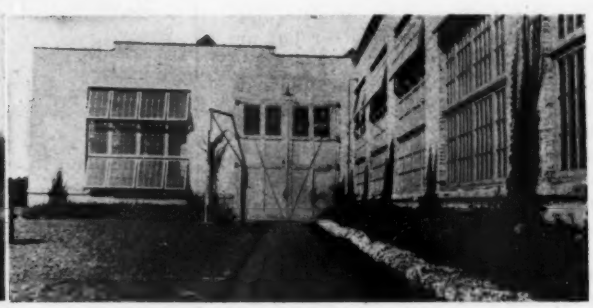
Concrete dock approach. Lake Superior & Ishpeming Railroad.



Pushing ore up the dock approach.



Shops, round house and office.



A corner of the car shop.

Types of locomotives used on the Lake Superior & Ishpeming Railroad. Upper photograph shows a heavy Consolidation locomotive with tender booster. Below it is shown a Consolidation locomotive of 1910 rebuilt by L. S. & I. R. R. with la.g. cylinders and back end.

over the first locomotives of 41,200 pounds or 161 percent, the revenue load eastbound to the dock increasing from 900 tons a train to 3,000 long tons, an increase of 2,100 tons or 233 percent; heavier locomotives could be used but for prompt movement of empty and loaded cars the present power seems best for our service.

In 1901 The Cleveland-Cliffs Iron Company purchased the Munising Railway with the townsite of Munising and a large area of timber land; this railroad had been projected by two large land companies in 1895, from Munising, a new town to be built by these companies on Munising Bay on the southern shore of Lake Superior, to a connection with the Chicago and North Western Railway at Little Lake, a distance of 37 miles, through solid virgin pine, hemlock and hardwood forest.

Dead River bridge on L. S. & I. R. R. The track is 135 feet above the water. This bridge, originally supported on two columns, was too light to safely carry the heavy Consolidation type locomotives built in 1916. Hence the arch was added increasing the loading from Coopers E-40 to E-60.

In 1902 the Marquette & Southeastern Railway was built by The Cleveland-Cliffs Iron Company from a connection with the Lake Superior & Ishpeming Railway in North Marquette to a connection with the Munising Railway at Lawson, a distance of 27 miles.

The mileage of these two railroads in 1902 was 70 miles and was the beginning of the development of the timber territory contiguous thereto.

These railroads through a heavy timbered territory furnished a supply of forest products for industries and there was built at Marquette a charcoal iron furnace with 110 tons daily capacity, with a modern chemical plant using about 220 cords of wood daily; sawmills, veneer and wood working industries and the plant of the Munising Paper Company now having (*Cont'd on page* 770)

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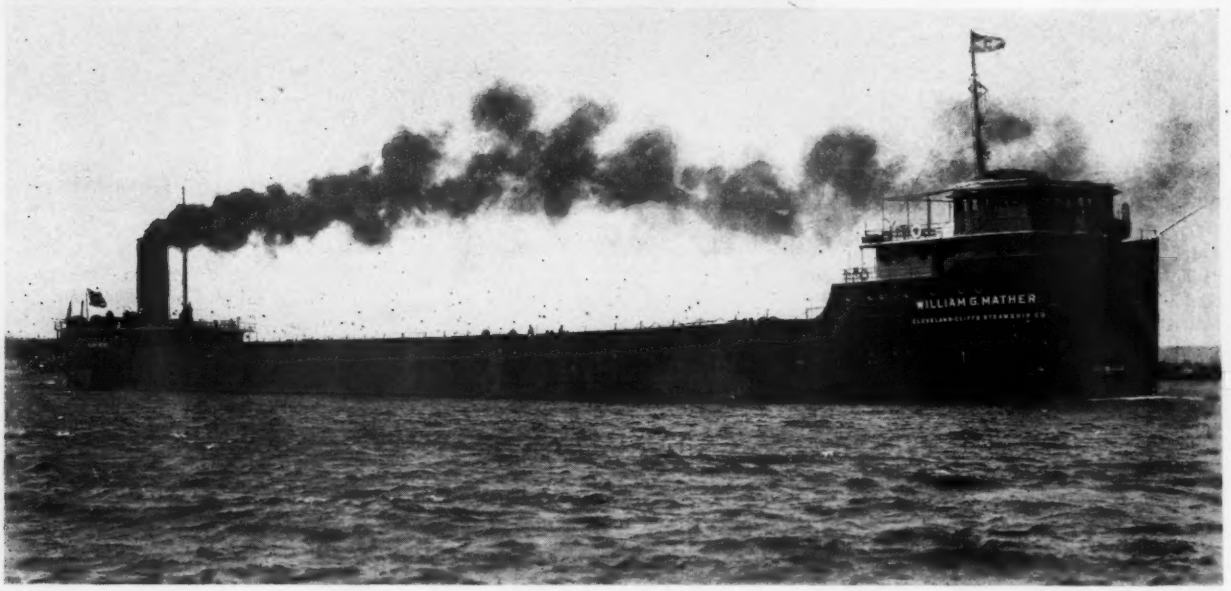
TRANSPORT IN

The George Sherman, from an old painting.

The William G. Mather, flagship of the present fleet.



THE greatest pageant of inland commerce in the world passes down the national waterway of the five Great Lakes each year. In the annual navigation period, an average of eight months, more than one and one-half times the combined yearly tonnage of the Panama and the Suez Canal passes through the locks at the Soo. This tremendous marine traffic, carrying the basic industrial staples of iron ore, coal, grain and stone at rates about one-tenth the average railroad freight charge, is a true tribute to American inventive genius and business management.

The modern lake freighter of 12,000 to 13,000 tons capacity, carries more cargo per cubic foot displacement than any other type of vessel ever designed; and loading and unloading machines are almost human in their ease of manipulation and in their effectiveness. The dispatch and navigation of this large fleet through tortuous crowded waterways is an exact science, at which the ocean sailor, used as he is to the far flung reaches of the sea, can only marvel.

This inland marine fleet annually moves without strain, to an industrial world, more than 120,000,000 tons of bulk commodities; in fact in 1928 the tonnage was approximately 127,000,000 tons. It indeed has served mightily in the rapid development of the mineral and agricultural resources of the Northwest. A short period, well within the memory of many men now living, has seen this region develop from trackless forest into a thriving mineral and agricultural region. The prosperous lower lake cities, which are the natural recipients of this bounty, owe no small part of their industrial growth to this efficient transportation system, which annually furnishes them with an ever increasing amount of their basic bulk materials.

The Cleveland-Cliffs Iron Company has always been prominently identified with the development of modern lake transportation. The original incorporators of the company made the first shipment of iron ore through the Sault Ste. Marie Canal in 1855 in the Brigantine Columbia, thus opening up the possibilities of iron ore transportation from the mines to blast furnaces. Lake freight at that time was $3 per ton.

Up to that time, literally, a man, a

* Manager, Marine Department, The Cleveland-Cliffs Iron Company.

ING IRON ORE

By A. E. R. SCHNEIDER *

Transportation of iron ore, coal, grain and stone form basis for greatest inland commerce in world, more than one and one-half times the combined yearly tonnage of Panama and Suez Canals passing through Soo locks during season—The story of transporting iron ore graphically told.

horse and a cart had sufficed for the interstate transportation of iron ore.

Prior to 1867 the company's ore was carried by so-called "tramp" vessels, chartered from time to time as deliveries to lower lakes were desired. In 1867 the company first became interested in vessel property, acquiring one-half interest in the bark *George Sherman*, having a capacity of 550 tons. The tonnage shipped by the company in this year was 75,864 tons, and the rate of freight $2.98 per ton.

Shipments increased gradually, and we find the principals of the company convinced of the wide possibilities existing in iron ore transportation, and they, in conjunction with others, became interested in a fleet of four wooden steamers, named the *Geneva*, *Vienna*, *Sparta* and *Havana*—each with a capacity of 1,000 tons, and four wooden schooners called the *Genoa*, *Verona*, *Helena* and *Sumatra* —with a capacity of 1,100 tons each. This was in 1872 and shipments in this year aggregated 151,724 tons.

Practically all the bulk freight at this time was carried in wooden vessels, averaging about 1,500 tons capacity with sails for added motive power, laboring under the added handicap of manual loading and unloading. Navigation in shallow, poorly dredged channels was extremely difficult. Indeed those of us who are used to 12,000 ton freighters loaded and dispatched on schedule closely comparing with the exact system of the railroads, can hardly realize the difficulties undergone by these hardy trail breakers.

Schooners were towed by tugs, singly or in fleets up to four and five or more, through the rivers between Lakes Superior and Huron, or Lakes Huron and Erie. The rest of the trip was made to ports under steam and sail.

At the docks, scores of men went into the cargo holds and shovelled every pound of ore or coal by hand, and other legions pushed their straining wheel barrows up the inclines to the docks. Four days of back-breaking toil was required to empty a vessel of average size. Today six hours does the trick with a cargo ten times as great. Where once the waterfront swarmed with men amid a forest of tall masts, now but a scant handful of overalled mechanics may be seen handling the whole cargo of a freighter, with a few lever turns and without any manual labor except in the clean-up of the ship.

As the company's shipments of iron ore in 1887 had reached a total of 270,441 tons and the practicability of steel ships was proven, the company a year later contracted for its first steel steamers, the *Pontiac* and the *Frontenac*, each having carrying capacity of about 2,500 to 2,800 tons. These boats were the Leviathans of the lakes at that time.

As the size of ships increased, there was somewhat of a corresponding reduction in freight rates, and in 1880 the average freight rate from Marquette to Lake Erie ports was $1.22.

Closely paralleling this marine growth, was the development of loading and unloading facilities for the rapid handling of this highly specialized commerce.

Alexander Brown introduced a single cable wired rig which served the purpose of hoisting a hand filled bucket from the hold and conveying it to storage. Mason next invented the self filling bucket, or clam shell, which soon became an integral part of the unloading equipment, and in 1899 George Hulett designed a type of unloading machinery original in its conception and truly economical in operation. These improvements eliminated the hand filled tub and the wheelbarrow and made loading and unloading a matter of hours rather than days.

To these developments must be added the gradually increasing channel depth which was forced by the increased size of ships and the amount of ore carried. Thus, in the early days of iron ore movement loading depths were restricted to 12 ft. by reason of the shallow channels in the St. Marys River and in the water way connecting Lakes Huron and Erie. Depth in the first Soo passage, the old State Canal, was about 13 ft. and in the locks 11½ ft. The Weitzel lock (1870-1889) gave 17 ft. followed successively by locks of gradually increasing depth, width and length. Today the present Soo locks are about 1,350 ft. long, 80 ft. wide, and have about 24½ ft. of water on the sills. The true epic of this picture can best be realized by the fact that with each additional deepening of the water, keels of boats were laid down which would require an even greater depth.

In 1892, to take care of the possible increase of iron ore shipments, the company contracted for the steamers *Pioneer* — 1,600 tons — and *Cadillac* to carry 2,300 tons. These boats were designed especially for the quick loading and unloading of grain and to engage in the Welland Canal trade, in case it was

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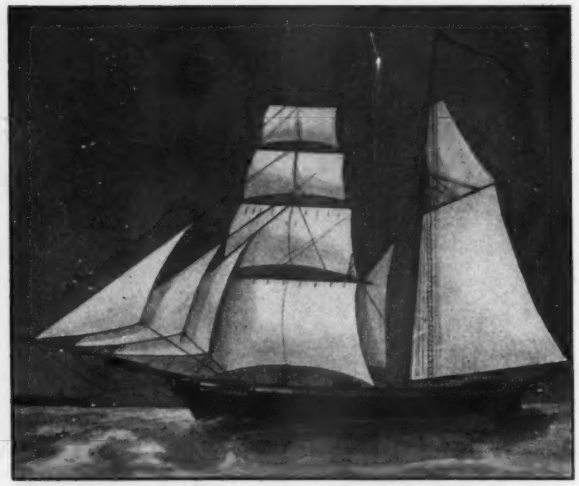


The brigantine Columbia, which carried first ore cargo through Sault Ste. Marie Canal.

1,791,124 tons in 1899. Freight rates, with the coming of the larger boats, were reduced in that year to an average of 84 cents.

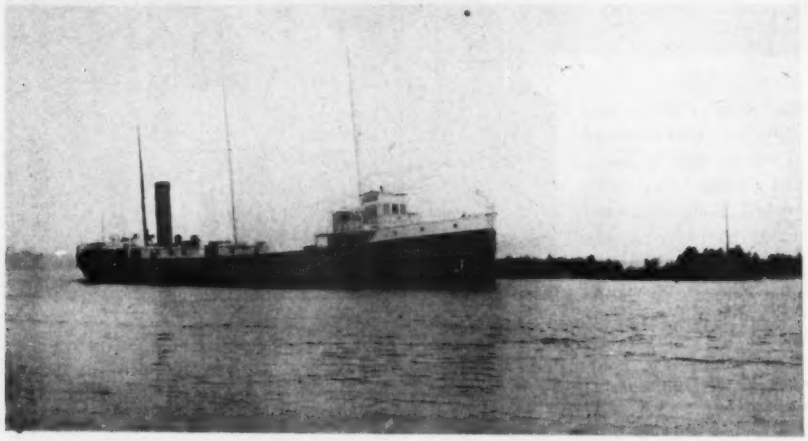
In 1904 the boats of the 3,000-ton class and under were becoming obsolete in the ore trade and the modern side-tanked, arch-constructed with capacity of 9,000 tons, was also brought out, and the following year the company contracted for three 10,000-ton boats called the *Ishpeming*, *Michigan*, and *J. H. Sheadle*.

During the war the company found it advantageous to dispose of its smaller boats. It increased its fleet by direct purchase, and later began with the construction of still larger boats; the *Pontiac* in 1917 and the *Frontenac* in 1923, with a capacity of 12,000 tons each. In 1925 the second steamer *William G. Mather*, the flag ship, was built, with a carrying capacity of 13,000 tons.

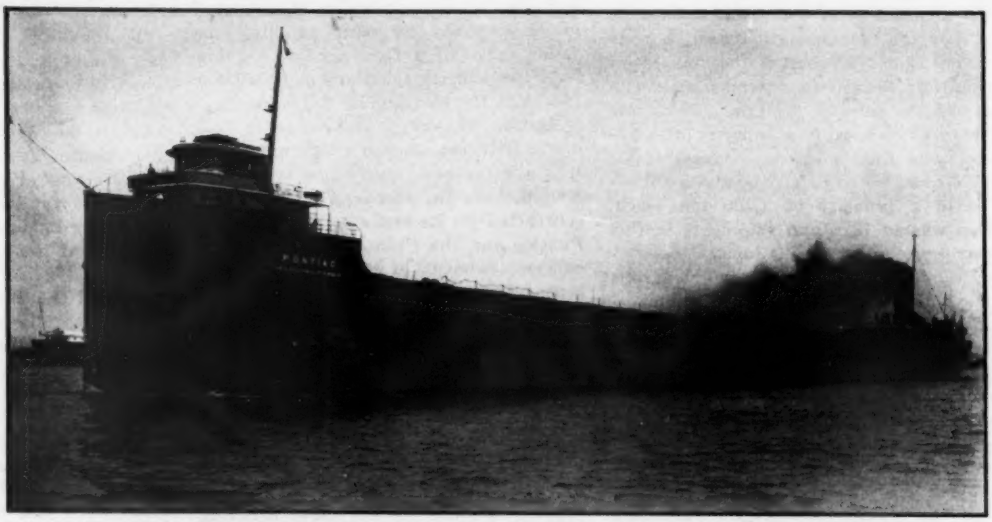
This last-named boat embodies all the innovations and improvements that have been developed in bulk freighters. In the building of the three last-mentioned ships considerable thought was given to the care and comfort of the crews, and the quarters were arranged so there would not be more than two men in a room.

A steady growth has been maintained in the company's ore shipments, and in 1928 the total had reached three and one-half million tons.

Navigation on the Great Lakes is open from about the 15th of April to November 30, and sufficient ore must be brought down to carry the furnaces through until the following season, and necessarily large stockpiles of ore are carried at furnace yards or lake front docks. Deliveries are scheduled in approximately equal monthly quantities, but this does not always obtain. Mine operations and



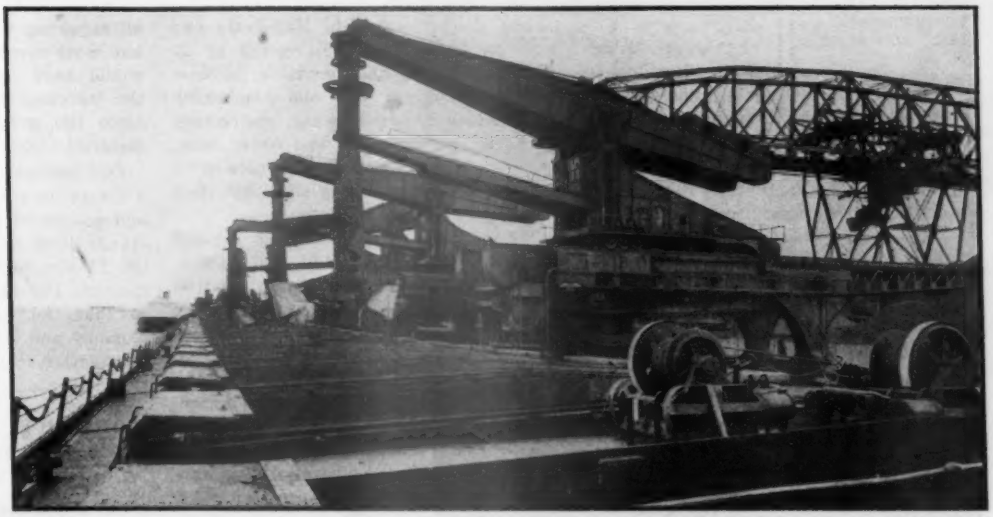
The old steamer Pontiac and the present steamer Pontiac.



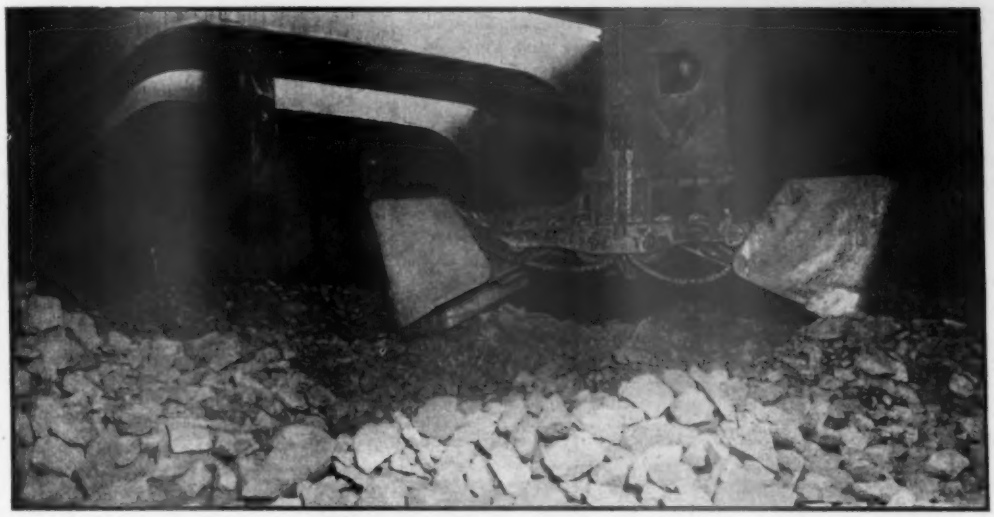
necessary to engage in other trades for lack of ore tonnage. However, shipments of ore constantly increased to 859,984 tons in 1892, and there was no occasion to use the boats in other than the ore trade. The average freight rate on iron ore at this time was $1.06.

The continued growth of ore shipments brought a demand for larger ships, and in 1898 the company was instrumental in the building of two boats named the *Presque Isle* and *Angeline*, with a capacity of 6,200 and 6,400 tons, respectively. Some other ships were also acquired at this time to take care of the increase of ore shipments, which totaled boat was built with a capacity of 10,000 tons. This was a forerunner of more ships being built of this class, and the company in that year brought out the steamer *William G. Mather*, having a beam of 60 ft. and at that time only one lock at the Soo could accommodate a boat of that breadth.

In that year the steamer *Peter White*, ability of consuming interests to take ore forward sometimes makes it necessary for some to anticipate schedules, in order to bring about a regular movement, which is very necessary on account of the short season of navigation. Unless this was done, there would not be sufficient railroad and vessel capacity to serve all.



Steamer Pontiac unloading at C. & P. dock, Cleveland.



Rigs unloading lump Cliffs Shaft ore, C. & P. dock, Cleveland.

Vessels now owned and managed by The Cleveland-Cliffs Iron Company, with their tonnages.

THE CLEVELAND-CLIFFS STEAMSHIP COMPANY

William G. Mather	capacity..	13,000 tons
Pontiac	capacity..	12,000 tons
Frontenac	capacity..	12,000 tons
J. H. Sheadle	capacity..	10,000 tons
Michigan	capacity..	10,000 tons
Ishpeming	capacity..	10,000 tons
F. A. Bailey	capacity..	10,000 tons
Pioneer	capacity..	9,500 tons
Grand Island	capacity..	8,500 tons
Marquette	capacity..	7,200 tons
Munising	capacity..	6,300 tons
Cadillac	capacity..	6,300 tons
Negaunee	capacity..	6,300 tons

THE PRESQUE ISLE TRANSPORTATION COMPANY

Peter White	capacity..	9,000 tons
Angeline	capacity..	6,800 tons
Presque Isle	capacity..	6,600 tons

THE FONTANA STEAMSHIP COMPANY

Yosemite	capacity..	5,700 tons
Colonel	capacity..	5,700 tons

THE SCHNEIDER STEAMSHIP COMPANY

Cletus Schneider	capacity..	5,800 tons
R. J. Paisley	capacity..	5,800 tons

TRANSPORTING ORE FROM MINE TO DOCKS
(from page 765)

daily capacity of 75 tons of bond paper; at Big Bay, in connection with the operations of the Brunswick Lumber Company, is a pin mill with an annual capacity of one million finished ten pins.

During the years 1903 to 1905 extension was made westerly from Little Lake to the Gwinn district iron mining territory, about 6 miles; from Marquette to Big Bay, a distance of 24 miles; and to the timber territory easterly from Munising, about 30 miles.

In 1924 the Lake Superior & Ishpeming Railway was consolidated with the Munising, Marquette & Southeastern Railway, which then consisted of 130 miles of main line and branches and was a consolidation of the Munising Railway and the Marquette & Southeastern Railway which had been merged in 1911.

This consolidation in 1924 diversified the traffic by reason of serving the forest product territory and, in addition, ore was received from the mines located in the Gwinn district, about 45 miles from the ore dock at Marquette.

The total mileage of main line and branches is now 162, with sidings of 93 miles and leased tracks of 19, making an aggregate of 274 miles.

Equipment consists of 32 locomotives, 13 passenger cars, 1,883 freight cars, of which 1,335 are steel ore cars, and 31 work equipment units.

The shops, located in Marquette and built in 1919 and 1922, consist of 20 stall roundhouse and turntable, locomotive shop with 5 pits and blacksmith shop attached, power house, storehouse, oil house, coaling plant and water tank, car shop with space for 30 cars with paint shop, wood-working shop and steel shop in connection.

The grounds surrounding shops and dock are landscaped and the lawns, shrubs and flowers present an attractive appearance unusual in such locations.

The tonnage, in tons of 2,000 pounds, handled during the year 1928 was as shown in the tabulation below.

Railroad conditions and methods are constantly changing, but to what extent is not often realized by those not connected with railroad operation; so far as our own road is concerned, it has been practically rebuilt and equipped in the past 30 years from the standards of 30 years ago. Wood cars of 30 tons capacity were worn out and replaced with steel cars of 50 tons capacity; road locomotives have been scrapped or transferred to switching service and replaced with others of nearly triple the power; the wood ore dock was worn out and became obsolete and replaced with one of steel and concrete; wood bridges replaced with those of steel to carry the heavier locomotives and cars; old shops abandoned for new of greater capacity and efficiency; heavier rail for heavier loads, all requiring a larger capital investment but most necessary, for without that it would have been impossible to handle the increased tonnage or to have overcome the greatly increased labor and material costs.

Our railroad is not much more than a dot on the railroad map, but its growth and volume of tonnage is substantial; it stands sixth for iron ore transported in the 11 ore docks in the Lake Superior district; the facilities are kept modern so that the business is handled with economy and dispatch and therein is the satisfaction in ownership and operation.

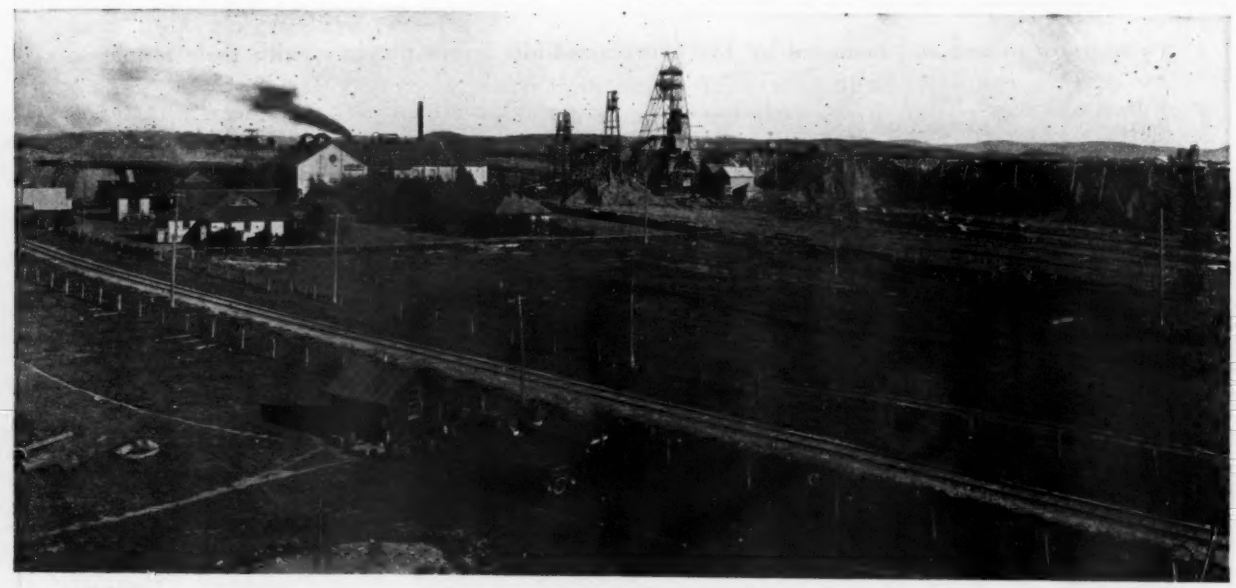
	Number cars	Tons	Percent
Total products of agriculture	540	9,357	.22
Total animals and products	127	1,539	.04
Total products of mines	65,134	3,484,157	81.23
Total products of forest	19,534	667,955	15.56
Total manufactures and miscellaneous	3,998	114,309	2.67
	89,333	4,277,317	
All L. C. L. freight	.....	11,722	.28
Grand total C. L. and L. C. L. freight	89,333	4,289,039	100.00

COMMERCE DEPARTMENT REPORTS ON MINERAL OUTPUT

The Department of Commerce reports that the mineral output of the United States in 1928 was slightly less than that in the preceding two years, chiefly because of smaller coal production. The greatest gains in manufacturing were by the iron and steel and petroleum refining industries. The nonferrous metals industry also had an increased output.

"Mineral production last year continued on a high level, although, because of a decrease of 4 percent in coal output, the general index was 1 percent lower than in 1927 and 2 percent below the peak of 1926," says the department.

Production of various commodities increased in 1928 by the following percentages over 1927: iron ore and pig iron, 4 each; steel ingots, 15; coke, 3; copper, 9; zinc, 2; crude petroleum, .1; and gasoline, 14. Bituminous output decreased 5 percent and that of anthracite 4 percent.



General view of the Maas mine, taken in 1920

By W. H. MOULTON *

INDUSTRIAL RELATIONS WORK *of*

The Cleveland-Cliffs Iron Company

Close contact is maintained between executive and personnel—Welfare work includes a remarkable hospital, rest cottage, visiting nurse service, and pension system—Housing is given special attention and prizes are awarded for best kept premises—Without anything of the paternal entering into the welfare and industrial relations work, this company has established an enviable relationship with its workers.

THE well-being of the employes of any company is fully as important a factor in its successful operation as the condition of the mechanical or other equipment, and should receive just as careful consideration. Many plans are undertaken by The Cleveland-Cliffs Iron Company, in a spirit of friendship and good will towards its employes, as well as because of a rational understanding of their economic value.

During the life of The Cleveland-Cliffs Iron Company the contact between the officials and the men has been very close, but as the employes have increased in number it has not been possible for the higher officials to keep in such intimate touch with the individual men as was true while this group was small. For this reason it becomes most important that the spirit and ideals of the organization be carried to the men by others and through methods which reflect the good will of these officials and their esteem for those men who are giving their best and most loyal efforts in its service. Whatever has been undertaken along the lines of this special effort has been with this conception of the relation of the company to its people.

The first thing of importance is the condition under which the men work both in the matter of health and safety. Under the able direction of Mr. William Conibear, safety engineer for the company, efforts have been made to surround the men at the mines with healthful conditions, and everything possible has been done to promote the safety of the employes in the operation of the different properties.

Equal in importance to proper working conditions is that of satisfactory living conditions. It has always been the policy of the company to provide good homes for the employes, at a very moderate rental. Encouragement has been given employes to own their homes; and in these sections in which the land could not be sold, long-term leases have been given at a very low rate. In some instances houses have been erected and sold to the employes at cost; the payments generally being 10 percent at the time of purchase, and the balance to be

* Secretary, Pension Department, The Cleveland-Cliffs Iron Company.

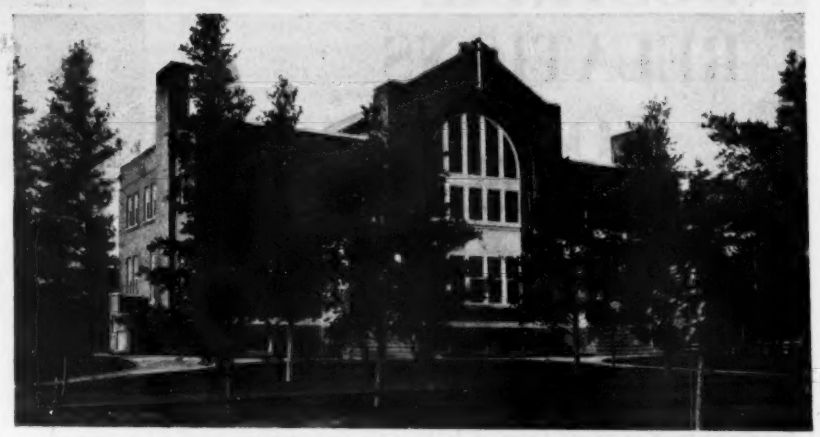
Gwinn High School

paid through a period of, usually, 10 years; the monthly payments being not much larger than the rental of a similar house not owned by the company.

The matter of good sanitation has always been carefully looked after, both at the mines and at home locations. The excellent system of ventilation in operation at the mines is one illustration of the benefit which has resulted from a study of conditions. This improvement means better health and longer life for the men.

An excellent medical service has been maintained to insure the best of care for the employes and of their families. Hospitals have been erected, served by the most faithful and competent physicians. The consideration given to these things is exemplified by the hospital erected at Ishpeming in 1918. It is modern in every particular and is fully equipped with everything required for the best of medical and operative work. A bacteriologist through his laboratory determinations is of great value to the physicians and their patients, and a trained dietician makes possible the best food service.

All the requirements of the College of Physicians and Surgeons are fully complied with, and because of this the Ishpeming Hospital is on the accredited list of approved hospitals. Only graduate and registered nurses are employed. This hospital of 50 beds serves the families of the company's men, and such rates are made to the employes and their families as to make it possible for operative work or medical treatment that in many cases otherwise would not be practicable. The benefit of this to our people and to the community can not be overestimated.



Above — Gwinn Club House

Right — Swimming pool at Gwinn, east branch of Escanaba River

The work of the doctors and the hospital force is supplemented by that of visiting nurses who give so fully of their time and services. In the year of 1928, our nurses made 9,009 professional visits to the homes of the sick, caring for these patients under the instruction of the physicians. It is impossible to calculate the value of the services thus rendered both in bodily improvement and a better outlook on life. The better we can make the individual, the better the whole structure becomes.

This form of welfare work has been further extended by maintaining a rest cottage each summer, to which tired-out or convalescing women can be taken for a period of rest. Many a woman has thus been able to take the first vacation period since the establishment of her own home, and its good effect has been manifest in numerous instances through-

Ishpeming Hospital

out succeeding months. Individual cases have frequently been worth all the expense involved.

Close contact is maintained with the many families, especially through the work of the visiting nurses. In cases of long-continued illness the needs of a family are brought by them to the attention of the officials, and assistance is rendered in the same spirit that anyone would assist their friends when such help was most needed.

Consideration has been given to those men who after long years of faithful service have at last found it impossible to continue at work by reason of age or disability. Pensions have been provided for the men reaching the age of 65 and who have worked for the company 25 years or longer.

The officials of the company were the first to publicly advocate an adequate workmen's compensation law for the state of Michigan. One of the company officials was on the commission that drafted the law which went into effect in September, 1912, and which has continued as a most successful law, with only such modifications as changed industrial conditions have warranted.

It has been considered by many that it is fully as justifiable to make some provisions for a man who, through long years of faithful service, has been incapacitated for further work as to pay workman's compensation to a man who is unable to work on account of an accident occurring possibly through his own lack of care and who may have worked for the company only for a short time.

The company has always encouraged the ideals of education, and it has approved and assisted in the providing of excellent school buildings with the best of equipment. The school building at Gwinn, shown in the illustration, represents the thought that has been given to provide the youth with favorable environment and with good educational facilities during those years in which their understanding of life and its countless problems are developed and established.

A well-considered community life has a large share in the encouragement of ideals and every reasonable effort has been made to provide and maintain those conditions that will be the most helpful. The company has aided in maintaining a Y. M. C. A. at Ishpeming, which serves as a center for all the general community activities. In other sections, club houses have been erected with such facilities and arrangements as to serve the whole community. The club houses have the usual equipment of billiard and pool table, bowling alleys, game rooms, gymnasium and recreational halls, shower baths, and special rooms for the use of the women. One of the club houses in addition to the other features has a fine swimming pool.

In those places somewhat remote from the larger cities, moving pictures have been introduced and have proved to be of value. In these clubs the men pay a reasonable fee and thus feel that it is theirs to be used by them and their families for their (*Continued on page* 780)

Two houses among those honored for the "Best Kept Premises"

SAFETY WORK at The Cleveland-Cliffs Iron Company

By WILLIAM CONIBEAR *

As a pioneer in safety work in the ore country, this company has established a splendid record—Real program adopted and carried out—Monthly inspections, central safety committee, enforcement of standard safety rules, training in mine rescue and fire prevention.

THE Cleveland-Cliffs Iron Company was one of the first of the iron mining companies of the Lake Superior District to organize a safety department and to start a definite campaign for the elimination of accidental injuries to workmen. The first step was the appointment of a committee of officials in the fall of 1910 to consider the subject, and, following their report, a safety inspector was appointed in February, 1911. The next step was a thorough inspection of all mines, shops and power-plants, in collaboration with the mine superintendents and the mechanical and electrical departments. While all unprotected machinery and electrical equipment were being guarded and all unsafe places about the mines both on surface and underground were being fenced off, guarded or eliminated, a committee was appointed to draw up a standard set of rules for the safe conduct of mining operations. These rules were based on the report on uniform mining laws by a committee composed of Walter Renton Ingalls, J. Parke Channing, J. R. Finlay and John Hays Hammond, for the American Institute of Mining Engineers, the American Mining Congress and the Mining and Metallurgical Society of America.

Two sets of books of rules were published, one book being complete for the use of foremen, superintendents and other operating officials, and the other covering only the general rules and regulations for workmen. The latter was published in English, Finnish and Italian, and a copy of it was given to every workman and a receipt taken for the same, and this practice is still continued. Special rules have been given to hoisting engineers and locomotive operators. Eleven editions of rule books have been published since 1911, embodying the alterations and amendments that have been adopted since the first edition was issued.

INSPECTION

The department is in charge of a safety inspector who makes monthly inspections of all mines either alone or with a committee. A blank report is provided comprising 165 questions, which outline the investigation that must be made in order that he may discharge his duties, but he is at liberty and is expected to report all dangerous conditions that come under his observation and which may not be brought out by the questionnaire. His reports are submitted to the manager and to the president.

Other inspections are made periodically by various committees of three members each who are selected from the mines and plants of the company. The safety inspector accompanies each committee on its tour of inspection, in the capacity of secretary but has no voice in the recommendations which a committee may make.

These inspections are as follows:

All mines by a committee consisting of one superintendent and two mining captains.

All mines by a committee consisting of three shift-bosses.

Each mine by a committee of three workmen from that mine.

* Safety Inspector, The Cleveland-Cliffs Iron Company.

Surface equipment at all mines by a committee consisting of a mechanic, an electrician and a surface foreman.

In the operation of deep mines there are certain hazards that must be given careful scrutiny, and it is the policy of the company to assign the responsibility of supervising the equipment and working conditions where these hazards exist to competent men. These men are required to make written reports of their inspections to the mine superintendents, who forward them to the central office of the company, where they are reviewed and recorded by the safety department. These reports are as follows:

Daily inspection of hoisting cables and cages by the mine mechanic.

Daily report of cage operation by the cage rider.

Weakly inspection of cage and skip roads by the mine timber foreman.

Weekly inspection of all ladderways, including the second outlet, by the mine timber foreman.

Monthly inspection of hoist and overwinding and slack-rope warning devices by an engineer of the mechanical department. Daily inspections are made by the stationary engineers.

Monthly test of cage safety catches. This is usually made by the mine blacksmith and must be in the presence of the mine captain or superintendent.

Quarterly inspection of fire-fighting equipment by the mine mechanic or surface foreman.

Semi-annually inspection of electrical equipment by a member of the electrical department and the mine electrician.

During 1928 the following reports from these sources were received by the safety department:

Cage riders	3,175
Hoisting ropes	2,843
Skip and cage roads	405
Ladderways	386
Hoists	177
Cage safety catches	115
Fire fighting equipment	27
Electrical equipment	6
Total	7,134

Central Safety Committee

A very important part of the safety organization is the Central Safety Committee, which consists of the manager, the general superintendent, the superintendents of the various mining districts, the chief mining engineer, the chief mechanical engineer, the secretary of the pension and welfare department and the safety inspector. This committee meets once a month and discusses and classifies all accidents, using a classification key obtained from the Department of Safety and Relief of the Illinois Steel Company. This classification divides all accidents into three divisions.

I. TRADE RISK (Incidental and Non-Preventable).

II. NEGLIGENCE OF COMPANY:

1. Failure to use safety devices provided.
2. Failure to use proper tools or appliances provided.
3. Violation of rules.
4. Improper act or selection of improper method of doing work. (By foreman.)
5. Failure to instruct men as to method of doing work and hazards incident thereto.
6. Failure to provide safety devices.
7. Failure to provide proper tools, appliances or place to work.

III. NEGLIGENCE OF WORKMEN:

A. *Injured men:*

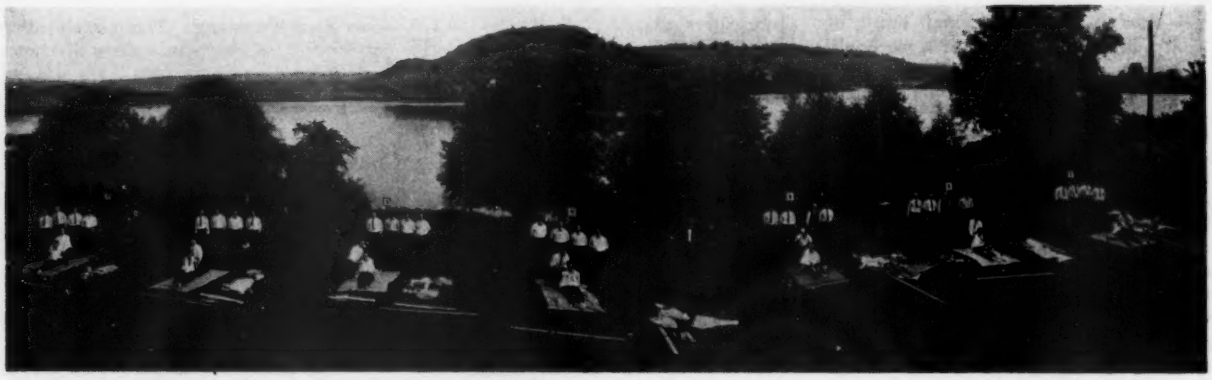
1. Failed to use safety devices provided.
2. Failed to use proper appliances or tools provided.
3. Violation of rules.
4. Improper act or selection of improper method of doing work. (By workman.)
5. Carelessness. (By workman.)

B. *Other workmen:*

1. Failed to use safety devices provided.
2. Failed to use proper tools or appliances provided.
3. Violation of rules.
4. Improper act or selection of improper method of doing work. (By workman.)
5. Carelessness. (By workman.)

The Central Safety Committee makes new rules or recommendations to cover new conditions or improved practices, and submits them to the manager for approval, before they are put into force. It also considers and acts upon all sug-

Safety flag raising event at one of Cleveland-Cliffs Mines.



Mine first aid teams participating in a contest.

gestions as to improvements in safe practice or safety devices that are submitted by employes, and recommends suitable awards. All matters of safety, the expedience of which gives rise to difference of opinions, are referred to this committee, which acts in a similar way to the legislative branch of the Government.

Investigation of Accidents

Every fatal accident is investigated and reported on independently by the superintendent of the mine or plant where it occurred, by a committee of three superintendents and by the safety inspector. Their reports are submitted to the manager and by him to the president. Each mine has a committee of three workmen who investigate all lost time accidents, other than fatalities. These reports go direct to the superintendents who forward them to the safety department.

Cooperation of Employes

An analysis of the underlying causes of accidents in the industrial world of today proves conclusively that the proportion resulting from carelessness and indifference on the part of employes is very high. This phase of accident prevention work, how best to educate men to eliminate pain and pecuniary loss to themselves, their families and fellow-workmen, is a problem that will not be solved easily nor within a short period.

It would seem as though the education of men in safety would be easy to accomplish since "self-preservation is the first law of nature" and the most important activities of human life directly minister to an enforcement of this law. In his development from infancy, man is busied in acquiring, from hour to hour, knowledge which subserves to self-preservation and nature takes it largely into her own hands to educate him in the safe conduct of his body among surrounding objects and movements.

In a normal man the instinct to defend and protect the body always exists and should form the basis of all attempts looking toward the promotion of safety. Upon closer observation, however, we find that man allows his activities in securing the necessities of life to take precedence over the precautions essential for his personal safety. The miner is no exception to this generalization, and he works in an environment which gives ample opportunities for the development of tendencies that work against his safety. His occupation is one which represents muscular effort, often under trying conditions; conditions which enlarge in men the personal viewpoint of life rather than the humanitarian. In his work he depends principally upon his own ability and resources, and absence of the constant supervision of a foreman is too often the only temptation needed for his selection of unsafe practices. Absence of daylight is an influence which does not join happily with the influences that are endeavoring to provide and maintain his personal safety.

Every reasonable and practical effort is being exerted by the company to instill in the minds of its employes that it stands unequivocally for safety in the operation of its mines. While it is granted that efficiency is the keynote by which it must successfully meet existing competition yet the policy of the company is such that there must be no loophole through which the employe can find a reasonable excuse for indifference for shifting the responsibility for his safety to the shoulders of the company.

The safety policy of an employer, as it is interpreted by the employe, is determined largely by the attitude and conduct of the foreman in the daily discharge of his duties. A mine foreman should be efficient in whatever capacity he may be needed, and to attain this qualification, he must know how to do things safely. With the object in view of training men to be fit representatives as foremen and developing a system of cooperation between them and the workmen, an educational department was conducted for several years. While the chief function of the school was the development of efficient men for promotion, at the same time they were taught to understand and appreciate that the safety of employes is a prime and fundamental consideration.

The cooperation of employes has been sought in many ways but space does not permit more than a summary of the most important, which are as follows:

Maintenance of safety suggestion boxes and an award given for each suggestion put in use.

Large and small bulletin boards posted with the safety poster service of the National Safety Council, descriptions of preventable accidents, photographs of unsafe practices, comparative accident records, etc.

Cards, labeled with safety warnings, given to all employes with due-bills and pay-checks.

Examination of employes periodically as to their knowledge of safety rules and their willingness to obey them.

Employes of mines having no lost time accidents for periods of three, six and twelve months given prizes.

The company's safety calendar given to all employes.

A safety bulletin issued monthly.

Safety conferences for foremen and safety mass meetings for workmen.

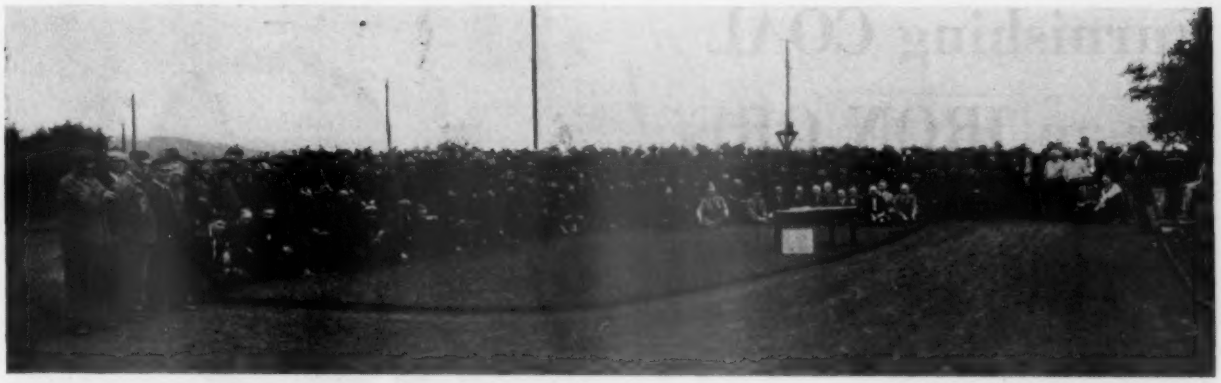
A safety flag flying at each mine or plant if exempted from lost time accidents.

Two banner safety flags; one flies at the mine credited with the most man-shifts worked without an accident and the other at the mine with the longest perfect record.

Goggles, hard hats and gloves furnished, either gratuitously or at reduced cost.

Safety Standards

During the 14 years period from 1911-1925, inclusive, we had an appreciable reduction in our accident rate but it was evident that too many employes, while interested in having safe working conditions, were inclined to hold the



Presentation of the Joseph A. Holmes Safety Award at the Negaunee Mine on June 22, 1928.

viewpoint that accidents are inevitable in the hundreds of daily operations characteristic of an industry like mining. We labored altogether too long under a conviction, more or less prevalent, that safety appliances and effective measures could not be devised that would prevent human recklessness or carelessness.

In order to correct these impressions a general conference of superintendents and foremen was called by the manager, and after a frank discussion of the problem, it was decided that a code of standards covering the important methods of mine operations should be drawn up and put into effect, backed by very rigid discipline. Accordingly, a series of local and general conferences were held for discussing each problem arising at the mines relative to the work before a code was adopted. At the present time, special standards are being enforced with reference to the hazards that were a prolific source of accidents. They embrace the following operations:

Haulage:

Equipment, ditches, tracks, lights, storage of timber, safety zones, etc.

Duties of locomotive crews and those having general application.

Explosives:

Surface storage; Transportation from surface to working places underground; Underground storage; Cutting and capping fuses; Lengths of fuses; Blasting.

Cages:

Equipment; Signals; Handling men and supplies; Duties of cage rider.

Mining:

Mining methods; Timbering; Repair work; Scraper equipment and operation.

These standards define the safe way of doing the jobs, which expose men to the hazards that experience has proven are accountable for the principal causes of accidents at our mines, and our men are instructed and compelled to meet these requirements. A failure to comply with them is sufficient reason to give the offending party a lay-off of three to six days and a second offense means dismissal from the employment of the company. Foremen failing to assume the responsibility of enforcing strict discipline are demoted.

Fire Prevention and Fire Fighting Standards

With the idea of putting the lessons taught by past fires into concrete form, so that they will be applicable to the mines of our company, a set of rules and specifications for fire prevention and fire fighting was drawn up in 1922. These are used as a basis in determining the precautions to be taken and the policy to be followed at each individual mine. This compilation was based largely on the recommendations of the engineers of U. S. Bureau of Mines, on the rules drawn up by a committee of The American Mining Congress, and on the recommendations of the National Safety Council.

These standards have been divided under five headings as follows:

I. *Prevention.*—Under this head come all fireproofing and other measures for reducing the likelihood of the occurrence of fire.

Accident. Let's All Be
Careful and Make It
Days
Surface 61 Weeks, no Accident
Morris Shaft 63 Weeks, no Accident
Lloyd Shaft 67 Weeks, no Accident
Sec. C Shaft 72 Weeks, no Accident

A safety-record bulletin board at one of the mines.

II. *Extinction.*—This heading covers fire extinguishers, water supply, etc., and all other matters connected with putting out fires.

III. *Segregation.*—Under this heading are treated all fire doors, brattices, etc., by which fire areas can be isolated or traveling roads separated from the rest of the mine.

IV. *Notification.*—Under this heading are grouped all recommendations dealing with warning the men in case of fire, summoning assistance, and directions for action when warning has been received.

V. *Extraction.*—This heading covers all matters dealing with getting the men out of the mine, such as mine-rescue equipment, rescue crews, second outlet, etc.

First-Aid and Mine-Rescue Work

This work was started in 1911 under the supervision of an employe of the U. S. Bureau of Mines, whose service was obtained for a limited period. The work has been carried on consistently ever since by a competent foreman who devotes his entire time to training and the maintenance of equipment. Crews at all mines are instructed monthly, in accordance with the standards recommended by the American Red Cross Association and the Bureau of Mines. Advantage is taken annually of the opportunity to receive additional training from the Bureau, which maintains a mine-rescue car with headquarters at Duluth, Minn., for the benefit of the mining industry of the Lake Superior District. Inter-mine exhibitions and contests are held and the company's physicians usually officiate as judges. Certificates of competency are given to those entitled to receive them by the company and also by the Bureau.

Each mine has a surface first-aid room in the change house, equipped with necessary appliances, and supplies are also kept in shops (*Continued on page* 780)

Furnishing COAL for an IRON ORE Company

By A. D. CARLTON *

Transportation of coal second in importance to that of iron ore—Modern equipment used to fuel vessels—Port Huron plant model of modern efficiency—Coal supplies upbound cargoes.

IN THE vessel trade of the Great Lakes, the transportation of coal from the lower to the upper lake ports is only second in importance to the flow of iron ore from the northern mines to the blast furnaces below. During a single season, approximately 35,000,000 tons of coal are moved from the bituminous fields of Ohio, Pennsylvania, West Virginia and Kentucky to Lake Erie docks and thence to the north.

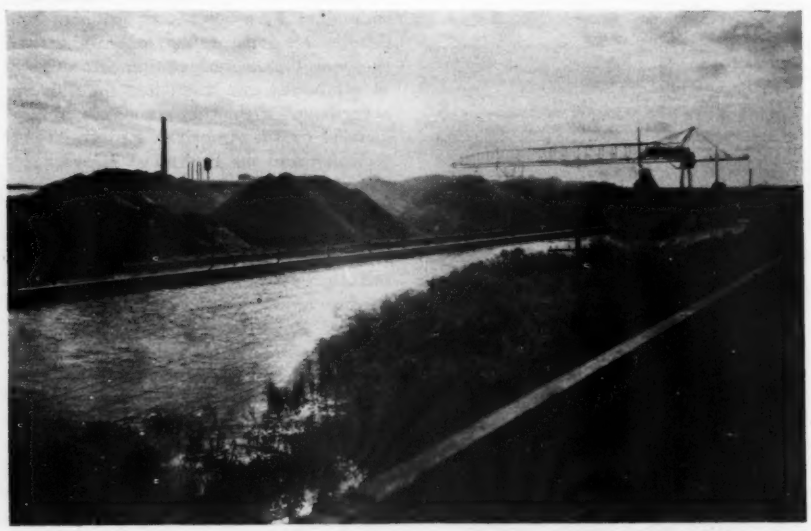
The coal trade of the Lakes not only provides the northern communities with coal of a quality difficult to obtain, but it opens a market of considerable importance for the coal industries to the south of Lake Erie. Moreover, the coal trade is of great importance in giving many Lake vessels upbound cargoes. For these reasons, most iron ore companies with vessel and furnace holdings are likewise interested in coal, either directly or indirectly.

While the principal business of The Cleveland-Cliffs Iron Company is the production and marketing of iron ore, many other important lines have been developed in the course of the company's evolution, over the 79 years of its existence. The company not only owns and operates Lake vessels, railroads and blast furnaces, but it is engaged in an extensive business of mining and selling coal as well. Having its inception 12 years ago, the coal department is the youngest of the company's important departments.

Like all of its activities other than iron ore, the company entered the coal business to meet certain definite requirements created by its expanding operations. These needs were twofold. One was to supply upbound cargoes for the company's vessels. The other was to supply by-product coal to some of the blast furnace plants in which the company was interested. Accordingly, in 1917 the Ethel group of mines was acquired. This property, of approximately 4,400 acres, is located in the so-called Logan field at Ethel, W. Va., and consists of three well-equipped mines, operating in the Chilton seam. Docks at various points of the Great Lakes were established and the mines were soon providing coal for the railroads, and for the northern departments generally.

Later on the company acquired a third interest in a tract of 4,442 acres in

* Manager of Coal Sales, The Cleveland-Cliffs Iron Company.



Coal Dock, Green Bay, Wis.

Greene County, Pa., now known as the Mather Collieries. The coal from this latter acquisition tended to displace the coal from the Ethel mines for by-product purposes and as a result the company developed a sales department within the coal division for the purpose of marketing the output of the Ethel mines. With the growth of the sales department, it gradually took on other coals which it handled on a brokerage basis. In addition the company acquired an interest in the Low Volatile Coal Company, located in the New River field and operated in the Beckley and Sewall seams. A large part of the output of these mines is distributed to the general trade.

Rapid expansion of the coal branch of the company led to the purchase in 1923 of a dock at Green Bay, Wis. The handling capacity of this dock is 250,000 tons of coal annually, and it was acquired partly for the purpose of furnishing an outlet for the products of the Ethel mines and partly to add to the tonnage of the vessel department. In 1926 another dock was established in Escanaba, in conjunction with certain plants located at that point. This property is now known as the Escanaba Coal and Dock Company, with a capacity of 150,000 tons a year.

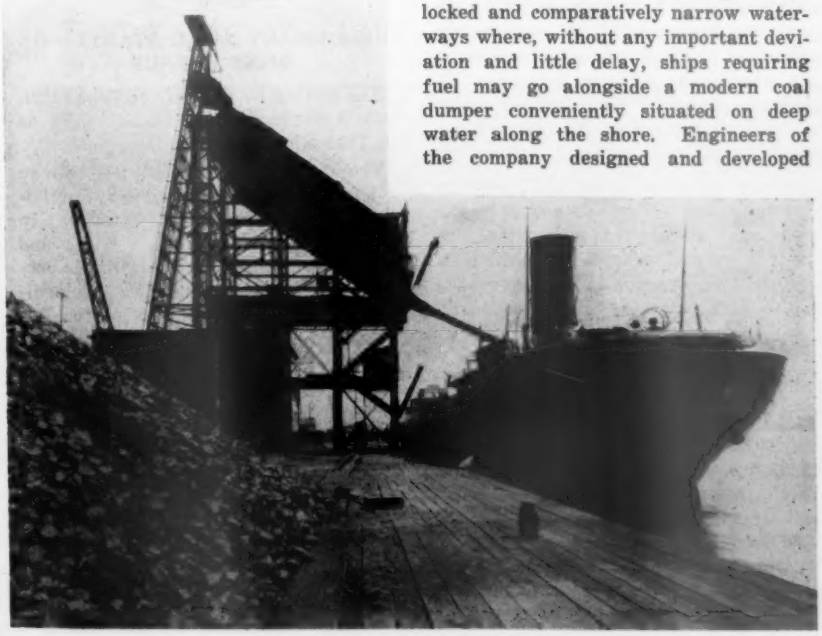
About two years ago another branch of the coal department devoted to railroal fuel was established, with the result that a railroad fuel business is being developed upon a rapidly increasing scale.

One of the most interesting and successful developments in the coal department has been the establishment of a modern, efficient lake vessel fueling plant located at Port Huron, Mich. The inauguration of this plant represents a radical departure from the practices of the past. Bunkering coal upon ships on the seaboard as well as on the Great Lakes, except in those instances where a ship is taking on a cargo of coal, has invariably for decades been accomplished in a crude and primitive manner. Even under the most ideal conditions it was practically impossible to be certain as to the weight of coal under the old methods of bunkering. No check or standard existed such as is by general consent and recognized custom observed in practically all modern transactions of business.

Following a thorough survey of the situation, the company came to the conclusion that there was an opportunity for the establishment of a modern fueling equipment. The courses of ships in lake trade take them through landlocked and comparatively narrow waterways where, without any important deviation and little delay, ships requiring fuel may go alongside a modern coal dumper conveniently situated on deep water along the shore. Engineers of the company designed and developed what is now known as the Port Huron Coal and Dock Company, located at the upper end of the St. Clair River. This plant is a modern steel structure, electrically operated, with a storage capacity of 700 tons of coal in two bins. Both bins are mounted on standard railroad scales. They are filled from a stock pile by belt conveyors and skip buckets automatically operated. Owing to the large storage capacity of these bins, and the efficient method of filling, the company is able to fuel a vessel at this dock more quickly than at any other dock on the Great Lakes. By the use of the belt conveyors and skip buckets the coal in the bins is replaced as fast as it is emptied, thereby eliminating any delay when a series of ships arrive close together.

Vessel unloading coal at coal dock, Escanaba, Mich.

Notwithstanding the rapidity with which the new plant operates, a force of only 5 men is required, compared with about 20 ordinarily required to man the old-fashioned style of fueling plant. The site of this plant was selected with great care. Should a boat be fueling and one or two boats be waiting to fuel, they can tie up at the lower end of the property which, of course, is more satisfactory than going to anchor in the river. The plant is at one of the widest points on the St. Clair River, so that boats downbound can turn and head upstream and boats upbound can head over to the port side and come directly into the dock. Another advantage is that of being located on the Port Huron side of the river, which is more convenient for boats leaving the dock that must turn, and for boats downbound that must make their



The steamer Wm. G. Mather taking on fuel at the vessel fueling dock, Port Huron, Mich.

turn on a port wheel and then practically get about in their own length.

Because of its strategic location, but even more particularly because of the fact that for the first time in the history of the Great Lakes boats may buy fuel according to standard and accurate weights and at a saving of time, the plant has attracted wide attention. As a result of these advantages, its business has enjoyed a remarkable growth.

In the period from its beginning in 1917 through the acquisition of the Ethel Mines, the coal department of the company has experienced a steady expansion, and now embraces the supervision of purchases and sales of coal required by all the plants in which the company is interested, including railroads, lake vessels and domestic trade in lower lake commodities, as well as dock territories in the north.

INDUSTRIAL RELATIONS WORK
(from page 773)

own best interests. This effort to provide a recreational life during leisure hours is well worth while. The work in the club houses is supplemented by plans for outdoor activities, especially for the youth. One illustration of this is the swimming pool on the East Branch of the Escanaba River at Gwinn, maintained for a number of years under the careful supervision of the club house force during the summer months. These grounds and swimming pool have now been taken over by Marquette County as one of the county parks.

Special activities have been encouraged and The Cleveland-Cliffs Mining Club is an organization of the mine captains and foremen and the various officials of the company meeting once a month during the winter months and having an annual outing day sometime during the summer. The Power Club is a similar organization for the mechanical and electrical force, functioning on a similar general plan. These clubs serve a very useful purpose in giving opportunities for the discussion of various problems in relation to their work, and for the formation of better acquaintance among men coming from somewhat separated locations.

Effort has been expended to make the home surroundings as pleasant as possible; and since 1894 prizes have been offered for the best kept premises, vines, window boxes, and vegetable gardens. These prizes have been won only by constant and continuing effort throughout the seasons, and the homes of our people show the rather remarkable results that may be obtained with a reasonable effort and without any great expense. The school authorities see the benefit to the scholars who have engaged in this work. Better surroundings and better living is reflected in all private and public relations.

For a number of years educational classes were held for those men qualified by age and experience for positions of responsibility in the mine work, and most thorough courses of study were given in all subjects relating to mining conditions and mining operations. Other men have been trained through educational classes in electrical work, thus building up from our own men a force to handle the electrical development of the company. Many of these men are now filling responsible positions with the company. Assistance has been given in the teaching of English and American ideals to foreign-speaking employes, and also in the matter of naturalization. The work has been done at the club houses, the Y. M. C. A., and through the evening classes held in the public school buildings.

The company has fully recognized the services rendered by the members of the American Legion, and has assisted that organization in the different cities and towns and has provided a commodious club house fully equipped for Legion headquarters at Negaunee; and cooperating with the Oliver Iron Mining Company it has provided similar headquarters for the Legion at Ishpeming.

The company has always appreciated the work of the churches, and has lent its aid to all denominations in their efforts to maintain a strong religious life in these communities. This has done much to make these cities and locations excellent examples of law-abiding and well-living people.

Industrial enterprises are directly benefited by all such agencies and the company has been prompt to recognize the value and to assist whenever possible in any plan tending to the betterment of conditions among its employes, their families, and the communities in which its operations are conducted.

In the affairs of industrial relations, new problems will continually arise demanding consideration and study, and the proper and reasonable solution of them will very generally produce results having real social and economic value.

SAFETY WORK AT CLEVELAND-CLIFFS
(from page 777)

and at shaft and pump stations underground. Many miners carry a metal first-aid kit while at work. Five district rescue stations are maintained, each of which is equipped with permissible self-contained mine-rescue breathing apparatus, portable electric lamps, tanks of oxygen, regenerating material, etc. The rescue apparatus has been replaced several times since 1911 in order to comply with new standards.

Labor turnover, sickness and advancing age bring changes in the personnel of an organization, and as this work demands intelligent men who are physically fit, new men are recruited from year to year. From 1911 to the present time a total of 1,221 men have been trained, of whom 567 are now working for us.

Accident Record

Our longest period of operation without sustaining a fatality was exactly 15 months. During this period an average of 2,312 men were employed. Our best individual mine record was established by our Negaunee Mine, which was operated continuously for a few days less than 10 years without an employe being killed. During this period 686,414 man-shifts were performed and 3,760,000 tons of ore mined. In recognition of this achievement a certificate of honor was awarded the employes of the mine in June, 1928, by the Joseph A. Holmes Association.

As this article is being written, our Morris-Lloyd Mine has been operated the past 459 days without a lost-time accident, with a total of 78,717 man-shifts worked. Three other mines were operated during 1928 having had a combined total of but eight slight accidents.

Our accident frequency rates for recent years are as follows:

Year	Number of Lost-Time Accidents	Rate per 1,000 Shifts
1927	211	.351
1928	123	.228
1929 (6 months)..	40	.145

PRELIMINARY WORK STARTED ON MINE CENSUS

The Mining Division of the Census Bureau is conducting preliminary work on the 1930 mine census.

The questionnaire which the Bureau will send to the mining industry for filling out is in course of preparation. In order to have some of the latest and most authentic information which is necessary to the content and accurate mailing of the questionnaire the Census Bureau is cooperating with the Bureau of Mines and other organizations which are in constant touch with the industry. Shortly after January 1 of next year the questionnaire will be mailed to mining interests. Officials of the Census Bureau request all mine owners, operators and others in the industry to cooperate by promptly returning to the Bureau the information sought by the questionnaire as it will expedite an early publication of the returns on the industry.

The PIONEER FURNACE

By DR. E. J. HUDSON *

First charcoal furnace in Lake Superior Region blown-in in 1858—Present furnace has wood carbonization and by-product chemical plants.

IRON ore was discovered in the Lake Superior region (Marquette Range), in 1845. Three years later the first iron was produced from the ore in a forge of the Jackson Iron Company. Because this region was heavily covered with hardwood, suitable for the production of charcoal, many furnaces were constructed, the first being completed and blown in by the Pioneer Iron Company (which later became a subsidiary of The Cleveland-Cliffs Iron Company), in April, 1858. The second furnace was blown in in May, 1859. Both furnaces were located in Negaunee, Mich., a short distance from the spot where iron ore was first discovered by an Indian Chief, Marji Gesick. They were 30 ft. square at the base, 20 ft. at the top, 30 ft. high and were constructed of rough stone. The walls were 9 ft. thick, the inner walls being lined with fire brick. They were equipped with old-fashioned ox bow iron pipe stoves.

Charcoal, made in small behive kilns, and ore were transported to the furnaces by wagons and sleighs. Wheelbarrows were used to convey the ore, coal and

* Manager, Furnace and Lumbering Departments, The Cleveland-Cliffs Iron Company.

The inscription on the tablet reads: "The First Charcoal Blast Furnace in the Lake Superior region was built here by the Pioneer Iron Company. Construction was commenced in June, 1857; finished in February, 1858. No. 1 Furnace was put in blast April 18, 1858, and No. 2 Furnace on May 20, 1859. They were burned down and rebuilt in 1877. The last iron was made in this stack in 1893. Pioneer Iron Company, October, 1904."

Pioneer Furnace, Marquette, Mich.

canaba. The furnace had a capacity of 110 tons of iron daily and was operated until 1922, when the supply of wood, tributary to the plant, was exhausted.

In the fall of 1901 construction was started at Marquette, Mich., on a furnace with a capacity of 110 tons of iron daily, a wood carbonization plant, with a capacity of 220 cords daily and a by-product chemical plant. The furnace is 70 ft. high, 11 ft. inside diameter at the bosch, 7 ft. at the top and 7 ft. at the hearth. The three hot blast stoves are

Below—Skidding logs to railroad tracks and a train of chemical logs.

limestone up an incline to the tops of the furnaces. Each furnace had a capacity of 10 to 12 tons of iron per day. Both were destroyed by fire and rebuilt in 1872 and were operated continuously until 1893. When they came into the control of The Cleveland-Cliffs Iron Company, it was decided that these two old stone stacks, meagerly equipped with blowing capacity and iron pipe stoves, and wasting the by-products from the wood, should be abandoned.

In 1895 the company built a modern charcoal furnace and chemical plant at Gladstone, Mich., on the Little Bay de Noquet, about seven miles north of Es-

Above—Sleigh load of chemical logs and log loader.

Battery of beehive charcoal kilns.

At right (top)—Train of chemical logs
Bottom—Train of 12-in. wood in retort buggies

of the Roberts two-side combustion chamber type. The blowing engines, two in number, are of the Southwark horizontal vertical type. The boiler plant consists of 12 Sterling water tube boilers, aggregating 3,600 hp., equipped for burning coal, furnace gas, tar, oil and charcoal braize, and four 150-hp. boilers, equipped with Dutch ovens for burning saw dust and log refuse.

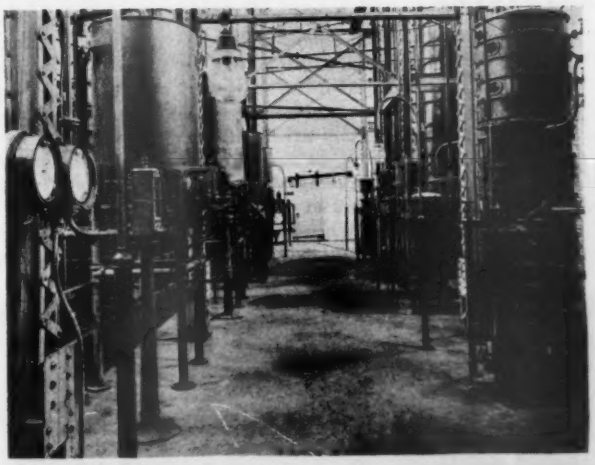
Three Prescott triple expansion pumps, each with a capacity of five million gallons daily, supply the furnace and chemical plants with cooling water, the daily requirements being two million gallons for the furnace and eight million gallons for the chemical plants.

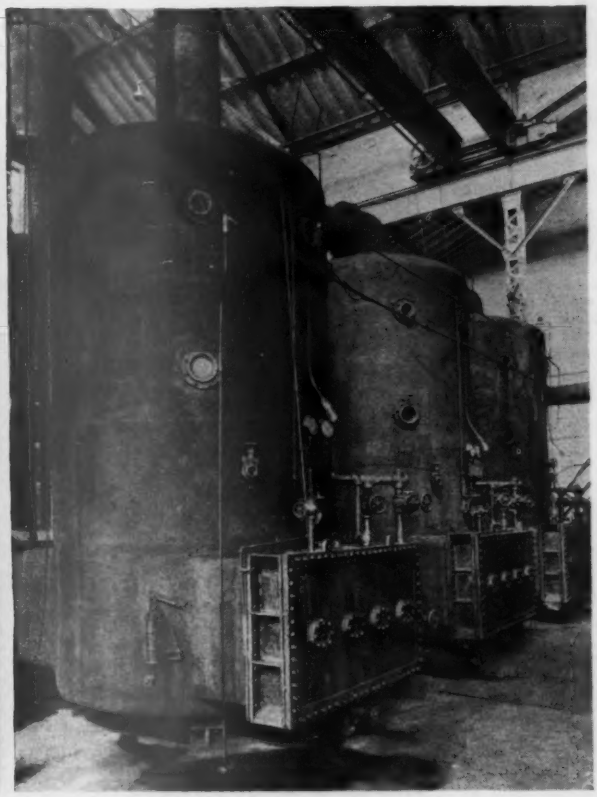
Electrical power is furnished by the Cliffs Power Corporation, a subsidiary of The Cleveland-Cliffs Iron Company.

For the operation of the two original charcoal furnaces, producing from 15 to 20 tons of iron per day, it was a comparatively simple matter to secure the necessary wood supply, and in those days the best of hardwood was used, being cut into 4-ft. lengths by choppers in the woods. With the development of the industry and the rapidly decreasing supply of wood choppers, it became more difficult to supply from 200 to 250 cords daily for the blast furnace; also as the demand for hardwood lumber increased for the manufacture of furniture, hardwood flooring, veneer and woodenware articles, it became more economical to save the logs suitable for these purposes and only carbonize the wood which was unfit for these finer products. It also became necessary to change the methods of operating in the woods, in order to cut over sufficient timber land, so that after sorting out the best wood there would remain sufficient wood unsuitable for these finer products for the blast furnace.

The logging operations of the company, which produce saw timber for hardwood lumber, logs for veneer and woodenware plants, ties, poles, pulpwood and shingle cuts, as well as the chemical logs which can not be used for these finer prod- (*Continued on page* 787)

Left — Continuous methanol refining columns.
Lower left — Methanol refining apparatus
Below — Acetate of lime evaporators





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Trappers shack on Grand Island after a heavy snow fall

The LAND DEPARTMENT of The Cleveland-Cliffs Iron Company

By JOHN M. BUSH *

THE Land Department of The Cleveland-Cliffs Iron Company was organized about 1896, with office and headquarters at Negaunee, Mich., necessitated by the large acreage acquired previous to that time. For a number of years it was actively engaged in the purchasing of timber lands to create a supply or a reserve of timber for the company's mines, furnaces and other industries. At one time the company controlled approximately 1,000,000 acres of land. This has been reduced by cutting and sales. In later years its activities became more varied.

The vast acreage owned by the company requires constant patrolling to prevent forest fires and trespassing. The department is active in a great many matters relating to the lands and forests of the Upper Peninsula of Michigan and has been instrumental in the organization of Forest Protective Associations, which have patrolled the timbered areas in the Upper Peninsula and it has carried on campaigns in forest fire prevention to conserve one of the Peninsula's most valuable resources.

It was also active in cooperating with the Government in the establishment of the Upper Peninsula Forest Experiment Station located at Ruse, Marquette County, Mich. (having donated a section of land to the Federal Government for this purpose), and the three national forests, comprising a total of 750,000 acres, which have just recently been created in the Upper Peninsula of Michigan. Cooperation is also given the Forest School of the University of Michigan and during the past summer a field school for forestry students has been maintained on company lands. Camping leases are issued to hunters and fishermen, at nominal rentals, with the understanding that they will cooperate in the work of forest protection.

When the timber is removed, the tillable land is sold at a reasonable price

* Manager, Land department, The Cleveland-Cliffs Iron Company.

A woods scene and a typical tree in the forests of The Cleveland-Cliffs Iron Company

Vast acreage owned requires constant patrolling — Reforestation — Experimental farms — Grand Island a natural game preserve — Wood working industries.

for agricultural purposes and every encouragement is extended to the new settler to become a successful farmer. The company themselves established experimental farms at Negaunee and Rumely, Mich. The result of this work is demonstrated by the excellent farming communities developed in past years in the vicinity of Chatham, Rumely and Trenary, where the company has been active in its lumbering operations and large areas of this cut-over land have been sold. In the mineral belt, farms and garden parcels are leased on reasonable terms and the people in the mining districts are encouraged in gardening, with the result that there are at this time approximately 1,500 of these leases in force.

The Land Department, in addition to the large land and timber holdings, also has the care and supervision of the real estate owned by the company in the various cities and towns in which the company is interested. In Ishpeming and Negaunee, lots are leased for residence purposes. At the present time there are over 1,000 such leases in force. In these and all the other communities where the company employs men it endeavors to improve the housing and sanitary conditions. Prizes are awarded each year for the best kept grounds, premises and gardens. In a great many cases, houses are built and sold on easy monthly installments, practically at cost.

In logging the company lands, all of the different species of timber are utilized and clean cutting is in vogue. The veneer logs, which are the cream of the forest products, are sent to the veneer mill, the next lower grade logs are sent to the woodenware factory for the manufacture of bowls, clothespins, and other wooden articles; the saw logs are sent to the sawmill to be manufactured into lumber, and the balance of the log timber, which is of a quality which can not be used in the above operations, go to the chemical plants at Marquette and for timber for the mines. The spruce and balsam go to the paper mill and the cedar is made up into ties, posts, poles and shingles. During late years, some experimental cutting has been done in the way of selective logging, and it is hoped that developments along this line will show that there is a possibility that the trees may be cut in such a way as to make a perpetual forest with cuttings at certain intervals.

A typical year's production from the lands of the company is as follows:

Saw timber	32,823,000 feet
Chemical logs	26,310,000 feet
Mining timber	222,649 feet
Railroad ties	143,315 ties
Shingles and tie cuts	39,710 pieces
Cedar poles and posts	68,712 pieces
Hemlock bark	6,752 cords
Pulpwood	5,775 cords

The sawmills, veneer mills, woodenware factory and paper mills are located at Munising, Mich., on the shore of Lake Superior, in close proximity to the land holdings of the company.

During the past 25 or 30 years, The Cleveland-Cliffs Iron Company has done considerable experimental work in reforestation and has a tract near Negaunee, Mich., which is now 27 years old and is a good demonstration of what can be done by planting. Reforestation has also been done on Grand Island.

Grand Island

Grand Island, owned by the company and located in Munising Bay, Lake Superior, contains 13,600 acres and it was decided to set aside this interesting timbered island as a natural game preserve. This decision made it necessary to stock the preserve, as only the native deer roved its forests, and purchases were made of moose, elk, caribou, antelope and foreign game birds, consisting of the "Black Game" of Sweden, capercailzie and grouse, the idea being to inhabit the island with only such game and game birds as can find their own food in the natural growth. It became necessary to provide roads and trails, affording access to the various portions of the island and, as visitors began to come, a hotel was needed, and this resulted in the development of the present hotel and cottages, boats and other equipment at the island. Excepting the national parks, Grand Island affords attractions not found in any part or resort in the country. In order to preserve the food supply in this preserve, it has been the practice during the past years to dispose of enough native deer to offset their natural increase and in that way keep the herd at about its present size. Sales are made principally to public game preserves throughout the country for propagating purposes.

The only known herd of Albino deer in captivity and being propagated is on Grand Island and is attracting considerable scientific interest.

The timber on the island is in its virgin state and is being left undisturbed with the exception of certain logging operations conducted in areas of hemlock which have already attained their full growth. Wherever any lumbering is done on the island, reforestation with pine and other conifers is made.

A great many people come to the island every year for their vacations, and during the months of July, August and September each year the company operates the Williams Hotel and 16 cottages on the island. A boat service is

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also maintained between the island and Munising on schedule and regular sightseeing trips are made to the far-famed "Pictured Rocks," which are on the mainland shore line east of the island. A number of cottages equipped for housekeeping are also provided and may be rented by vacationists.

A brief history of the island, which may be of interest, is presented herewith, to wit:

When Abraham Williams, a native of Vermont, sold his farm in Illinois and started with his family for the North woods, he had no idea of the exact location of his future home. He planned to settle in the vicinity of Sault Ste. Marie, Mich. Upon arriving there, set about to find suitable land near a settlement where he could make a living. He became acquainted with the Chippewa chief named Omonomonee, whose tribe of Indians made their home on Grand Island, about 130 miles westward on the shore of Lake Superior. The Indian chief was very friendly, and his description of Grand Island and its vicinity made such an impression upon Mr. Williams that he decided to locate there. They journeyed from the Soo to Grand Island in a schooner which had been used in the Blackhawk War, the journey being accomplished in two weeks. Previous to that time, in 1832, the American Fur Trading Company was granted a license to locate and transact business on Grand Island. The company had ceased its operations on the island before Mr. Williams' arrival there. He took possession of the fur trading company's buildings and erected others, together with a stockade for protection against hostile Indian tribes. The old warehouse used for trading purposes, as well as the orchards, homesteads, sugar camp, gateways and various buildings still remain to testify to the industry of Mr. Williams and his family.

Grand Island has been bountifully endowed by nature. It guards the landlocked harbor at Munising, a short distance from the renowned Pictured Rocks, and was called "Kitchiminiss" by the natives, meaning "Grand Island." The island has a rolling landscape, an abundance of native timber, and landlocked bays. No description by the pen can do justice to its natural beauty. Grand Island and the mainland near the present site of Munising were the homes of the Chippewas for about 200 years. Champlain, in 1642, in a trip westward in search of the "Lake of Copper," stopped at the island and spent a few days there. Several explorers visited Grand Island in the early days, and considerable was written by them of its natural beauty and historical interest.

Wood-Working Industries

In the development of its timber resources this company has endeavored to utilize all the forest products and from time to time has established various industries for the manufacture of products from its raw material.

Deer on Grand Island Game Preserve

The Munising Paper Company:

In 1902 The Munising Paper Company was organized, and constructed a plant at Munising, Mich., for the production of wrapping paper from hemlock. In later years a bleach plant was installed and this company is now producing annually approximately 15,000 tons of high-grade bond papers made from hemlock logs, spruce and hemlock pulpwood and slabs from nearby sawmills.

Birds Eye Maple Veneer

The Munising Woodenware Company:

In 1908 the Great Lakes Veneer Company entered into a contract with The Cleveland-Cliffs Iron Company for logs and established a plant at Munising, Mich. In 1912 The Cleveland-Cliffs Iron Company acquired an interest in the Great Lakes Veneer Company and its name was changed to The Munising Veneer Company. In 1911 The Munising Woodenware Company was organized for the purpose of manufacturing bowls, rolling pins, butter molds, spoons and various wooden articles for household purposes. These items being made from birch and maple logs. Later a department for the manufacture of clothespins was added, utilizing beech timber for this purpose, and in 1917 the veneer and woodenware plants were consolidated and taken over by The Munising Woodenware Company. At that time machinery for the manufacture of butter dishes was installed in the veneer plant. In 1920 extensive improvements were made in the woodenware plant, including a new power plant and enlargement of the clothespin department and the installation of modern saws and tools for the more economical conversion of timber into finished products.

The veneer mills are a very interesting activity of the company's operations and there can be seen the conversion of birch, maple, oak, ash and other woods into single ply veneers running from 1/64 in. to ¼ in. in thickness. These veneers are used in the making of ply wood which goes into doors and interior finish for buildings, furniture, automobiles, airplanes, etc. The Northern Michigan birch is the finest in the world and, in fact, is more beautiful than, and superior to, mahogany for a great many purposes. When stained with the colors and products now on the market, it presents a delightful appearance and any color scheme wanted may be easily obtained. The woodenware plant also presents interesting processes in the conversion of timber into chopping bowls and smaller items of woodenware for household purposes. It contains machinery especially built for the performance of the necessary operations to produce the finished article. These products are sold all over the United States through chain stores and others direct to the housewife.

Sawmills are operated to manufacture into lumber, lath and shingles all logs of every species which are unsuitable for use for other purposes.

THE PIONEER FURNACE

(*from page 783*)

ucts, are conducted by the lumbering department. All material is removed from nine acres of virgin timber daily, the average annual production of logs being approximately 22,500,000 ft. which, with the other products, make up approximately 8,000 carloads. In order to produce this material the company operates 4 to 5 logging camps with something over 300 men and 100 horses; two locomotives; four power loaders and two tractors. Forty-eight miles of railroad are required in the logging operations and the railroad is laid, lifted and relaid at the rate of 15 miles per year. From the main line, spurs are constructed as required, so that each section is provided with four miles of track.

The wood carbonized at the Marquette plant consists of maple, beech and birch logs not suitable for other purposes. Green logs 16 ft. in length are delivered to the sawmill, first sawed into 4-ft. lengths, split and then cut into blocks 12 in. long. The blocks are conveyed to a hopper, which delivers the wood into retort buggies, which go through three units of the carbonization plant and carries the residual charcoal to the blast furnace.

The three steps in the process are pre-drying, carbonizing and cooling. The pre-dryers, heated with waste heat from the retorts, remove water from the green wood. When the pre-drying is completed the wood is charged directly into the retorts, which are rectangular air-tight steel chambers, entirely enclosed in a brick setting and heated externally. Each retort is provided with two outlets on the side, connected with tubular condensers or coolers. The vapors and gases from the wood pass through the condenser tubes, which are surrounded by running water and are condensed to a liquid known as pyroligneous acid. The charcoal remaining in the buggies, after the distillation is completed, is transferred into the coolers, which are air-tight steel chambers of the same size, shape and capacity as the retorts, three coolers being provided for each retort. From 220 cords of wood there is obtained approximately 50 to 60 thousand gallons of pyroligneous acid daily. This acid is pumped to a battery of wooden storage tanks where tar, amounting to 3 to 4 thousand gallons, settles by gravity and is drawn off. This tar is the raw material for the manufacture of creosote oils and pitch. The pyroligneous acid contains a small percentage of tar and oil in solution and the first operation in the process is the separation of this soluble tar and oil from the acetic acid, alcohol and other products contained in the acid. This is accomplished by distillation in multiple effect vacuum evaporators.

Slacked lime is now added to the tar and oil free pyroligneous acid. The lime combines with the acid and forms acetate of lime. This material remains in solution and is separated from the methanol acetone, etc., by continuous fractional distillation, consisting in feeding a refining column with the neutralized liquor continuously and removing the volatile products or distillate from the top and the acetate of lime solution from the bottom of the column. The distillate contains approximately 60 percent of methanol, 16 percent acetone, 3 percent methylacetate, about 3 percent allyl alcohol and 18 percent water and is known as crude 82 percent methanol (wood alcohol.) The crude methanol, when treated chemically and redistilled, is separated into two products: pure methanol and a mixture of acetone, methyl acetate and methanol, known to the trade as methyl acetone. Denaturing methanol, used to denature grain or ethyl alcohol, contains methanol, acetone, methyl acetate, allyl alcohol, wood oil and other impurities. The acetate of lime solution from the bottom of the continuous column is partially concentrated in a triple effect vacuum evaporator. The concentrated solution is fed continuously into a pan, in which a steam heated cast iron drum rotates. This operation removes more water and produces an acetate of lime paste, containing about 25 percent water. The paste is removed from the drum by means of steel knives and is dried on canvas belts, travelling continuously over steam coils. The finished product is 80 percent acetate of lime.

Other products manufactured by The Cleveland-Cliffs Iron Company are shown on the accompanying chart.

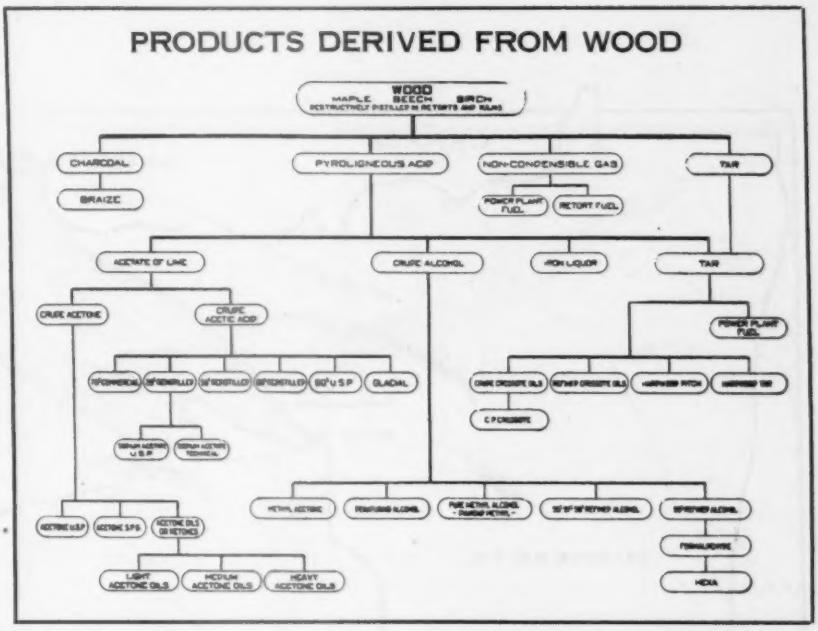
After the carbonization of the wood is completed, as outlined above, the charcoal is brought from the carbonizing plant to the stock house, in the buggies into which it was originally loaded as wood at the sawmill and dumped into the furnace skips, where it is charged into the furnace with ore and limestone, just as in a blast furnace using coke for fuel.

The Marquette furnace is thoroughly modern and operates much like the ordinary coke furnace, though it only produces about 110 tons of iron per day.

In former years charcoal iron was only used in the manufacture of special high priced casting, but owing to the development of the modern furnaces of increased capacity, and the complete utilization of the by-products, the cost of making charcoal iron has been brought to a point where it can be sold at a price not greatly exceeding that of coke iron, with the result that it is being used extensively for the better class of castings.

Lake Superior pig iron is made of the best Lake Superior iron ores, smelted with pure wood charcoal made from our own hardwood forests. The ores are crushed, then smelted under low temperature and low blast pressure; a natural smelting force, producing an iron of the highest quality, of fine, dense structure, great strength, of unusual flexibility, and with other peculiar qualities which are retained in the casting.

While the production of the furnaces and the use of charcoal as fuel makes charcoal iron more costly than ordinary pig iron, comparative figures show that the additional cost of using a percentage of charcoal pig iron in foundry mixtures is insignificant and well worth the difference for the results obtained. There is no type of pig iron as efficient for use in the manufacture of chilled rolls as charcoal pig iron. The use of a percentage of char- (*Continued on page 797*)



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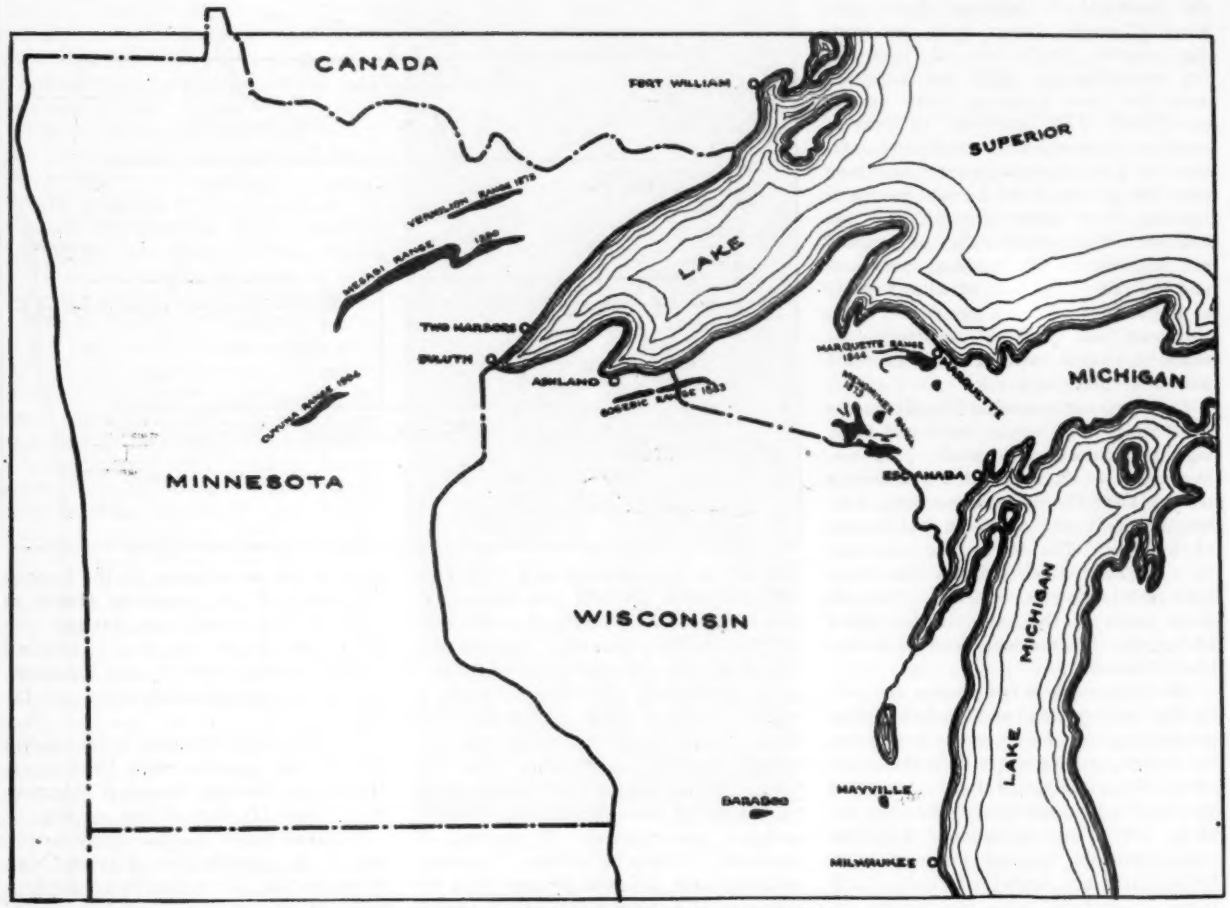

Figure 1—Iron Ranges of Lake Superior District

This great iron range has shipped a total of 815 million tons, and has an estimated reserve tonnage of 1,155,500,000 tons, which does not include large reserves of low grade ore.

THE Mesabi Range occupies a favored and unique position among the various iron ranges of the Lake Superior district due to the length and comparatively great breadth of its flat-lying ore bodies which have such shallow overburden, for the most part, that they may be mined by open pit methods.

As may be seen in *Figure 1*, which shows the location and dates of discovery of the various ranges in the Lake Superior district, the average distance from the Mesabi to the head of Lake Superior is about 75 miles.

These conditions make it possible for the mines on the Mesabi to produce and ship greater tonnage than any other group of ore bodies in the world.

The rail freight to the docks at the head of Lake Superior is $0.91, or about $0.012 per mile, and the lake freight, for an average haul of about 1,100 miles, approximates $0.00075 per mile, or a total of $1.74 for transportation from the mines to the lower lake docks.

The docks at Two Harbors, Duluth and Superior, from which Mesabi ores are shipped down the Lakes, have a combined capacity of 1,185,300 tons. There are about 350 boats, having a total capacity of 2,881,000 tons per trip, handling ore traffic on the Lakes. These vessels are up to 14,000 tons capacity and average about 8,250 tons.

The various units of the ore-handling agencies function smoothly and efficiently, so the vast stream of ore is kept moving without interruption during the six and a half months of lake navigation.

History

Ore was discovered on the Mesabi Range in November, 1890. The first shipment of 4,245 tons was made in 1892 and, in spite of the depression caused by the panic of 1893-94, development was truly remarkable. During the nine years to 1900, inclusive, over 31,000,000 tons of ore was shipped.

The first steam shovel brought to the range in 1893 was moved 12 miles overland, through heavy timber, from Mesaba to Biwabik.

Geology

The ore bodies on the Mesabi occur in the Biwabik formation of the upper Huronian. *Figure 2* shows the extent of the Biwabik formation from Birch Lake on the east, approximately 100 miles to the southwest, to a point 15 miles beyond Grand Rapids.

While the average width of the iron formation is nearly two miles, the ore-bearing portions average about half a mile. There are also many lean or bar-

IRON RANGE

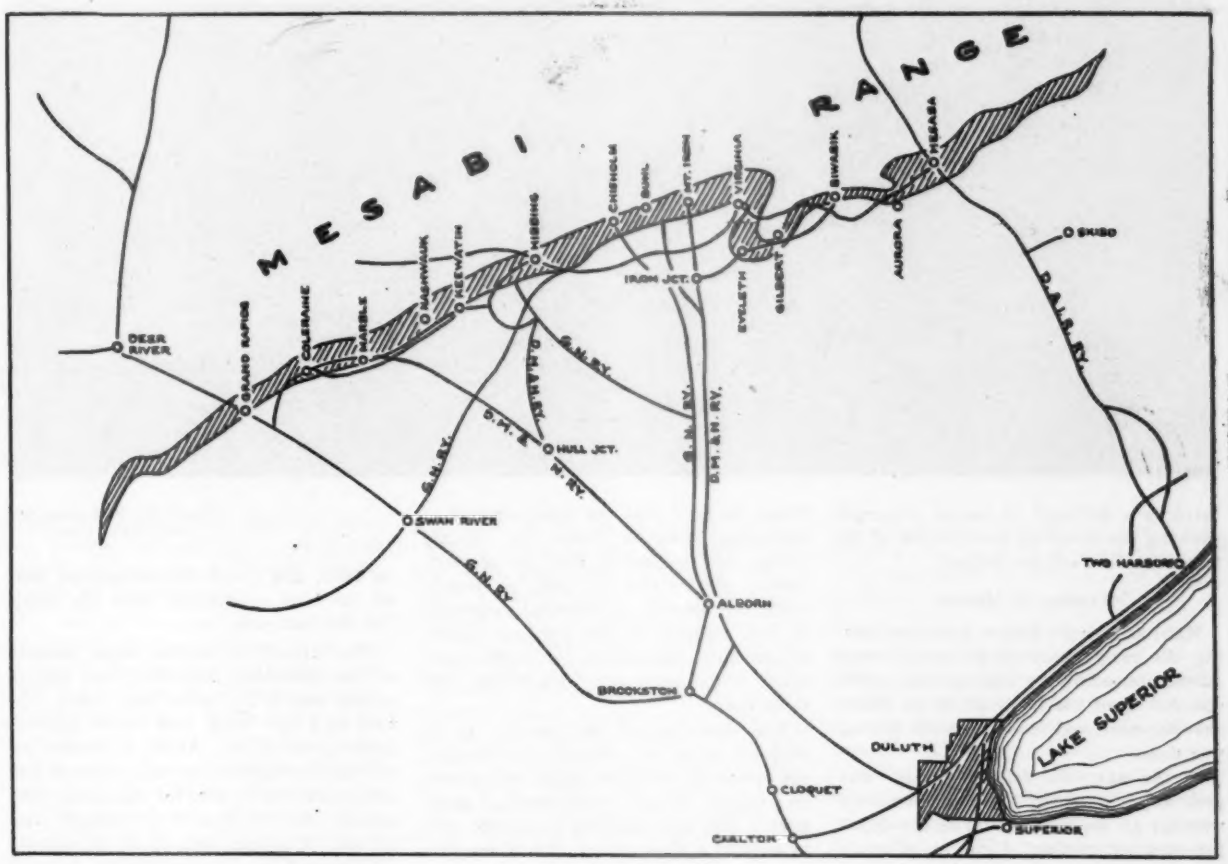

Figure 2—Mesabi Iron Range

By W. L. TAYLOR *

ren spots along the strike of the formation, only about 8 percent of which is ore-bearing.

Figure 3 is a generalized cross-section of the Mesabi, looking east, and showing the various members of the iron-bearing formation, which averages about 600 ft. in thickness.

The developed ore bodies are largely in the three lower members of the Biwabik formation and are the result of secondary enrichment of primarily lean, ferruginous silicates and carbonates. The majority of geologists hold the opinion that the iron-bearing formation was deposited in comparatively shallow coastal waters through organic agencies in the form of amorphous ferrous silicates, later altered to ferruginous cherts. Locally, these cherts are rather broadly grouped and are called "taconite."

Subsequent, rather gentle, earth movements have slightly inclined and more or less fractured these beds of taconite along joint and bedding planes. This fracturing allowed the percolation of ground waters which leached the silica, and in rare cases the iron, from the taconite, and left behind a rather porous, spongy mass of enriched iron ore. Due to the porous nature of the residual mass, sagging or slumping of the formation has taken place, resulting in the trough-like structure of many of the Mesabi ore bodies.

Roughly, the Mesabi can be divided into three sections, as follows:

(1) Eastward from Mesaba the formation is little altered, hard and siliceous, much of the iron occurring as finely disseminated magnetite.

(2) Between Mesaba and Keewatin the ore which occurs as hematite and limonite is so highly concentrated that practically all of it is shipped directly without beneficiation, except in some cases where the ore is crushed and screened.

(3) West of Keewatin a large part of the ore is not sufficiently rich in its crude state to be merchantable. These ores, which are mixed with sand, decomposed taconite and taconite, are called "wash ores."

EXPLORATION

Early prospecting on the Mesabi was done by means of test-pits, but as this method was slow and expensive, it was soon largely displaced by diamond and churn drilling, although test-pits are quite often sunk when wishing to secure a sample to determine its amenability to beneficiation.

It is often necessary to have information to supplement the original exploration work, and this secondary exploration is now, quite generally done on open pit properties, by means of churn drills of the large blast-hole type.

A hollow rotating chopping bit is sometimes used in what is known as

* Superintendent, Meriden Iron Company, Hibbing, Minn.

Figure 4—Mahoning and Hull-Rust Mines

"structure drilling" to secure a sample showing the structure and texture of the formation in wash ore bodies.

Methods of Mining

Many of the ore bodies developed during the early years of the range were mined, necessarily, by underground methods, but upon the introduction of steam shovels, more and more open pit mining was done.

In the past, the following ratio was generally accepted as determining whether an ore body would be developed for open pit mining: 1 cu. yd. of overburden to 1 ton of ore, where the vertical depth of overburden or stripping did not exceed 2 ft. for each foot of ore.

In last analysis, an ore body may be stripped for open pit mining if the cost of stripping, plus the mining cost, is less than the estimated cost of production by underground methods.

The above stripping ratio has been exceeded in a number of instances where the tonnage in the ore body is great enough to warrant the use of large, modern and efficient excavating equipment.

The wasting of the stripping or overburden removed in open pit mining is one of the problems in connection with this method of operation. It is of interest to note that the total amount of stripping removed from the Mesabi Range ore bodies to date is approximately 400,000,000 cu. yds., or nearly twice the amount of material excavated in the digging of the Panama Canal. Graphically, this amount of surface material would cover nine city blocks, two miles deep.

The character of the material to be stripped must be studied to determine the slopes at which the banks will stand. In average Mesabi overburden of sand, gravel, clay and boulders it is quite safe to assume a slope of 1:1, but where fine sand or muskeg swamp material is encountered, especially when wet or underlain by clay seams, much flatter slopes, up to 2 or 2½:1 must be figured.

Whenever possible, track grades do not exceed 3 percent and curves are kept below 10 degrees. The shovel cuts are planned in advance in accordance with the quality of ore which will be encountered. Ore banks ahead of the shovels are usually drilled with blast-hole type churn drills and blasted with black powder or 25 percent quarry gelatin dynamite.

At the present time there are approximately 100 producing mines on the range, two-thirds of which are open pits, producing 80 percent of the ore mined in 1928, and 10 of which shipped half of the total production from the range for the last year.

The largest pit on the range consists of the Mahoning, Hull-Rust and Sellers mines, and is 2½ miles long, from one-half to a mile wide, and covers approximately 900 acres. About 80,000,000 cu. yds. of overburden has been removed and the production to date for the mines comprising this pit is over 175,000,000 tons of ore. A million tons of ore is roughly represented by a cube 260 ft. in each dimension.

Figure 4 is a panoramic view of the Mahoning and Hull-Rust mines, with the Sellers in the background.

The main business part of the old town of Hibbing, or North Hibbing as it is now called, stood over the central background and a little to the right may be seen the remaining portion of the old town.

Where the extent of an ore-body is limited, or the depth of overburden too great to warrant stripping, underground methods of mining must be adopted.

In the early days of the range various methods of underground mining were in use, but the system which gave the most

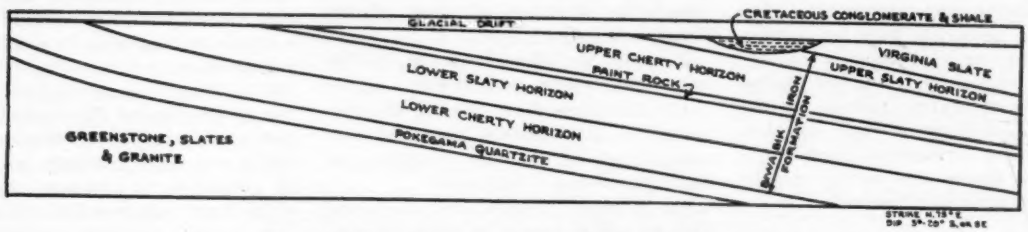

Figure 3—General section of Mesabi Range, looking east

satisfactory results and now the common method of mining, is known as "top-slicing and caving," and briefly, consists of the following:

At intervals of approximately 50 ft. along the main haulage level, raises are put up to the top of the ore-body, and from the top of these raises parallel cross-cuts are driven to the limits of the ore-body, or to the property lines. Beginning with the ore farthest from the shaft, slices 8 to 10 ft. wide and from 10 to 14 ft. in height are mined out at right angles to the cross-cuts, and extend half-way through the ore blocks toward the adjoining cross-cuts on either side. As soon as a room two or three slices wide is mined out, the bottom is covered with thin hardwood boards, underlain usually with a transverse reinforcing of pole lagging, and the sides of the room next the remaining ore are covered with woven wire fencing. The timbers are then blasted out and the room allowed to fill with surface material. As soon as one level is mined back a short distance, mining may be started at the outer edge of the next lower level and this repeated to the bottom of the ore-body, always retreating toward the shaft. After the first level is mined out, a mat of timber is formed and thereafter little trouble is caused by surface coming through the caves.

The majority of the underground mines on the range are electrically equipped.

As most of the mines, underground or open pit, are under 300 ft. in depth, pumping costs are slight, except in case of an occasional very heavy rainstorm, which may cause temporary trouble.

In a few cases, portions of an ore-body are too deep for economical track grades, or an excessive amount of the ore-body would be tied up under track benches in direct open pit mining. Where this situation exists, the surface is stripped as for open pit mining and the ore milled through raises to the haulage level of the underground workings. The ore is dumped directly into the raises by small power shovels or cars loaded by the shovels are dumped into the raises. This method of mining is known as "milling" and, while cheaper than underground mining, is more expensive than regular open pit operation.

Open Pit Equipment and its Development

The development of the steam shovel to its present state of efficiency is largely due to Mesabi open pit mining and the demand for faster and more economical production of ore.

The first steam shovel operated on the Mesabi was a 35-ton shovel equipped with a one-half yard dipper. Larger and heavier shovels replaced each other in rapid succession, until today the standard railroad type shovel of the 100-ton class is equipped with a 4-yd. dipper and many of the shovels of this size are mounted on caterpillar traction. A large number of full revolving shovels of the 300 and 350-ton class have 6 and 8-yd. dippers, and one shovel in use on the western end of the range has a 12-yd. dipper.

Electrically powered shovels were first used by The M. A. Hanna Company at the Wabigon mine in 1920. There are now many electric shovels in use and it is safe to say that the majority of new shovel equipment will have electric or diesel-electric power.

The larger type of shovels now in use, both steam and electric, will load cars standing on a track 50 ft. above the bottom of the shovel cut at the rate of about 1,000 tons an hour.

Locomotives in pit operation have passed through various stages of development, from little 6-ton saddle-tank dinkies, running on 36-in. gauge track, of 20-lb. steel, to the newer locomotives weighing 127 tons on the drivers, with auxiliary boosters on the tanks, are equipped with super-heaters and are the largest switcher-type engines in operation. They will haul 1,000-ton loads on a grade of 1½ percent.

For main line track in yards and pits 105 and 110-lb. steel is now used.

The first electric locomotives for open pit operation were placed in service by The M. A. Hanna Company at the Wabigon mine in 1924. These locomotives are 60-ton, switcher type, having overhead trolleys. The same company recently equipped their Mesabi Chief mine with 65-ton electric locomotives of the same type. It is reasonable to expect that many more electric locomotives will be used in future open pit operations.

The first stripping cars varied from 1 to 7 yds. capacity, and were dumped by hand on the waste dumps. About 16 years ago these cars were replaced by 12-yd. air dump cars, which were soon followed by 16 and 20-yd. cars, and now many 30-yd. cars are in use. The majority of the cars purchased in the last few years have apron doors hinged at the bottom so the load is dumped farther from the track and large chunks or boulders do not catch in the doors as with the older type of top-hinged doors.

The cars used by the ore-carrying railroads have also passed through several

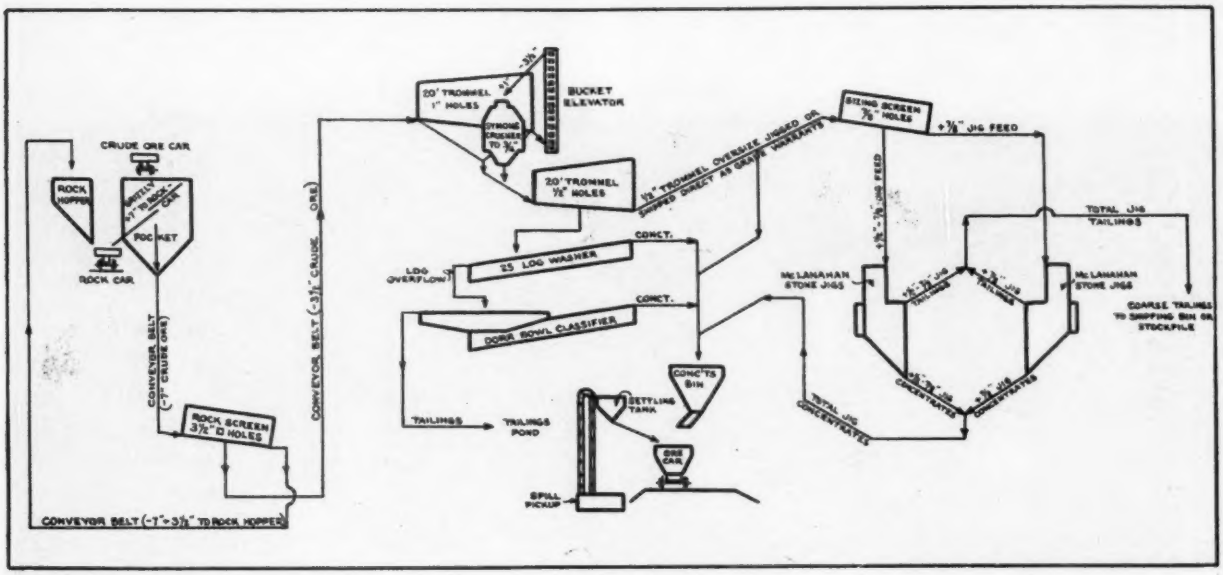

Figure 5—Flow sheet of washing plant

stages of development from the 30-ton wooden cars first in service. Steel cars are now in use of 50 and 75-ton capacity and a few of 85-tons. As the pockets in the docks are constructed on 12-ft. centers, the cars must be built 24 ft. long from center to center of couplers, so that each car will cover two pockets in the docks.

In early open pit mining all tracks were laid by man power and stripping was spread on the waste dump by hand. Stripping is now spread on the dumps with large power plows or spreaders and dump track is thrown to new alignment, when the dump is filled, with steam or gas driven track shifters. All temporary tracks are made up in panels, rail-length long, and new track is quickly built by locomotive cranes laying the panels. Switches are made up in two panels.

It is rather interesting that between 5,000 and 6,000 less men are able to produce more ore than 10 years ago. A few years ago 3 to 4 tons per miner was considered a good rate of underground production, while the average now is about 7 tons, individual cases being considerably higher.

Shipments and Reserves

The Mesabi shipped a total of 815,000,000 tons to the close of 1928, 91 percent of the total from Minnesota and 58 percent of the grand total from the Lake Superior district. The total reserve tonnage of the Mesabi Range is now estimated by the State Tax Commission as 1,155,500,000 tons, which does not include large reserves of low grade ore.

An accompanying tabulation shows average analysis for 1928 shipments from the Mesabi.

Ore Prices

The current prices for ores from the different ranges and of different grades are shown in the table below.

Premiums are paid for ore which is above the base analysis of 51.50 percent natural iron, and also, when the phosphorus content is lower than .045 percent, in a Bessemer ore. Penalties are exacted if the average analysis of the ore is below the base grade. The natural iron content of an ore is figured by deducting the moisture analysis from 100 percent and multiplying this remainder by the iron analysis of the ore when dried at 212 degrees Fahrenheit.

It is a rather peculiar situation that quite frequently the first tonnage sold in the spring, though it may be only 1 or 2 percent of the total sales for the season, determines the price of ore.

Sampling and Grading

As the ore is shipped from the mines it is sampled in five-car lots and these samples are analyzed while the ore is in transit to the docks. The ore grader then makes disposition of this ore in the proper group or block so that as the ore is dumped into the pockets in the docks, cargoes for the lake boats are built up to agree with the guaranteed analysis for the grade of ore in question. It is often necessary to mix ores from different mines or different parts of the same mine to secure proper average analyses for shipments.

Mining Costs

One of the most interesting things in connection with the production of iron ore is its cost, and average costs for open pit and underground mines are given below.

Taxes

Taxes are a large and important item in the cost of (*Continued on page* 798)

AVERAGE ANALYSIS FOR 1928 SHIPMENTS FROM THE MESABI

Grade	Tonnage	Nat'l Iron	Phos.	Silica	Mang.	Moist.	Percent of Total Shipment
Bessemer	9,998,773	54.21	.039	8.28	.40	9.75	28.7
Non-Bessemer	24,825,865	50.12	.073	7.86	.77	13.16	71.1
Manganiferous	57,179	41.07	.131	9.46	3.44	17.42	.2
Total	34,881,817						

CURRENT PRICES FOR ORES FROM THE DIFFERENT RANGES AND OF DIFFERENT GRADES

	Price at Lower Lake Ports	Natural Iron Base Analysis	Dry Phos. Analysis
Old Range Bessemer	$4.80	51.50%	.045%
Mesabi Bessemer	4.65	51.50%	.045%
Old Range Non-Bessemer	4.65	51.50%	.....
Mesabi Non-Bessemer	4.50	51.50%	.....

AVERAGE COSTS FOR OPEN PIT AND UNDERGROUND MINES

Method of Mining	Labor	Supplies	Miscel.	Develop.	Royalty	Total
Open pit	$.146	$.148	$.165	$.305*	$.438	$1.202
Underground	.947	.428	.220	.089	.466	2.150

* Stripping cost included in development.

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By courtesy The Cleveland-Cliffs Iron Company

Woodland roads near Gwinn, Michigan

Market Results of MERGERS, as Effected and Proposed

Consolidations of consuming interest carries with it consolidations of iron ore reserves—This will mean better market for producer from standpoint of both tonnage and price

By L. E. IVES *

ANY issue devoted to the iron ore industry would hardly be complete without comment upon markets for the product. It seems pertinent, therefore, to consider the results, from this standpoint, of some of the combinations that have been proposed or effected, upon the markets for Lake Superior iron ore. In doing so, it is unnecessary to be specific, and this will be avoided where possible.

At the end of the period of unusual prosperity that followed the signing of the Armistice, the iron ore industry on the Lake Superior Ranges found itself equipped to produce a much greater tonnage annually than subsequent events demonstrated was possible for the furnaces to consume. The merchant furnaces found that their markets for pig iron had suddenly vanished, and it has required the intervening years to bring about a very radical change in the operation of these plants to enable them to exist profitably under the new conditions. For a while they attempted to get along, but in the end, many have gone out of existence, due to shifting markets, different freight rate structures, etc. Others have come in as new plants, almost completely self-contained. Some of the older companies have been able to improve their practice and equipment, and thus continue. The net result has been a survival of the fittest.

The iron ore producers were perhaps slower to realize the main trend and to be guided accordingly, because as producers of the raw material, the effects were naturally felt there last. During the first years of the changing conditions, it was possible to effect economies in operation, as compared to the war period, that helped considerably. As a result, costs were lowered below points previously considered possible. This could not go on indefinitely. Things militated against the iron ore producers that perhaps were not faced by the consumers. Among these was the inability to shut down certain large producing units on the various ranges that had been developed to meet war needs. In so doing, they had assumed obligations in the form of leases, royalties and taxes, that could only be met by at least a minimum annual production. During the last few years, some of the properties falling within this description have been exhausted and through that means have helped the situation.

The above will perhaps give a picture of the conditions that have faced the furnaces and the suppliers of Lake Superior ore during recent years. During this time, the situation from both standpoints has been corrected and improved as much as possible through the methods outlined. These, however, were insufficient and apparently the steel industry is taking final steps to further correct conditions; in so doing, it is pursuing the same methods employed in other industries, combinations and mergers.

This trend in the steel industry began following the Armistice when the Bethlehem Steel Corporation absorbed the Cambria, Midvale and the Lackawanna Steel Companies. At that time it was intimated that a steel corporation was to be formed by the joining together of many of the independent companies, located principally in the Pittsburgh and Mahoning Valley districts or even farther West. That particular combination failed to materialize but has never been forgotten and it is possible that before long we may witness the same results brought about through a number of smaller mergers which, perhaps in the end, could or could not be grouped into a single company.

One may well ask what the effect of such combinations will be upon the ore producers, the merchant furnaces and the steel manufacturers from the standpoint of iron ore as a raw material. It is not difficult to see which way the trend lies.

Many of the steel companies mentioned in connection with such combinations are in themselves owners of iron ore from which they either draw a portion of their current needs or which is held in reserve for future requirements. A few of the merchant furnaces are similarly situated. Many of the iron mines, consequently, are owned by or operated for such steel works or merchant furnace interests. Aside from these plants and mines, we have left only a few of the merchant furnaces without reserves or supplies of their own and some of the mines without permanent merchant or steel works furnace connections.

The grouping together of the steel works in accordance with plans which have been outlined and proposed from time to time, carries with it as a corollary the grouping of such ore interests as are owned by the individual companies going into such combinations. Perhaps some of the individual steel companies entering into such combinations are not as well situated with respect to reserves as others, and, with the idea of improving their situation in this respect, have been and still are adding to their ore reserves. This, of course, is having a tendency to take such reserves off the market in so far as such ore being available in the future for merchant or future steel works furnaces that have no ore connections.

At this point it is well to consider that whereas it may be unreasonable to expect that the consumption of steel and iron will increase in the years to come at the same rate as in years past, nevertheless the consumption is bound to increase appreciably and the supplies of iron ore are going to be drawn upon more heavily.

Perhaps enough has been said to indicate and emphasize that by a series of consolidations among the consuming interests which carry along with them consolidations of (*Continued on page* 797)

* Clement K. Quinn & Co., Duluth, Minn.

ACTIVITIES of The BUREAU of MINES in the Lake Superior Iron Ore

Special studies have been and are being made on ground movement and subsidence, mining methods, ventilation, and pyrometallurgical methods for making ferro-manganese—Safety program includes training in first aid and mine rescue.

Ground Movement and Subsidence

DURING the years 1927 and 1928, Dr. W. R. Crane made a detailed study of ground movement and subsidence in the iron ore districts of Michigan. The purpose of this investigation was to determine the factors causing, controlling, and directing failure of ground due to mining operations, and to help solve the problem of underground mine support, or the size of pillars necessary to make the mine safe according to the depth of the workings and the strength of the ore or rock in the pillar. It was hoped to secure fundamental data upon which to base a definite method of procedure in the protection of property against damage resulting from mining.

The report on Dr. Crane's investigations in Michigan has recently been published as Bureau of Mines Bulletin 295. In addition to publishing these data, in which specific mines are not mentioned, Dr. Crane discussed the problems encountered in a number of the iron mines with the managers and engineers in charge, and made confidential reports on the conditions he found.

The results of this work have been most valuable to the mine operators, and have aided them to better protect the mines and property, as well as the workmen, against ground movement.

Mining Methods

Following the work of Dr. Crane on ground movement and subsidence, the mining division instituted a study of mining methods and costs as a part of a general study of the subject, which is being carried on in all the important mining districts of the United States and in Canada, and which will be extended to include other foreign countries.

A large number of mines have been visited and studied by the engineers of the bureau, but the papers which have been and are now being written dealing with mining methods and costs are prepared by members of the staffs of the mining companies who are most familiar with the conditions encountered and the methods employed.

The Lake Superior iron ranges afford a particularly interesting field in which to study mining methods because of the wide range of conditions as to size, form, and dip of ore bodies, depths below surface, strength, and hardness of ore and of wall rocks, structural irregularities, and character of overburden.

This wide range of conditions has necessitated the adoption of a number of quite different methods of mining, from open-pit mining and mining in large open-stopes, to top-slicing and caving methods. The principal methods in use are: Open-pit, power shovel, and open-pit milling; open-stopes with regular pillars; sub-level stoping, also an open-stope method; sub-level caving; top-slicing; shrinkage stoping; cut and fill; and combinations of these methods.

In selecting the method of mining to be used at a given mine and referring particularly to underground methods, such factors as support of stopes and surface, safety in working, cost of mining, rate of output desired, development required, percentage of dilution by barren wall rocks or barren and low-grade inclusions in the ore body allowable, and percent extraction of total ore must all be taken into consideration.

In some instances, conditions are such that the proper method to use is immediately apparent, but in others it is only after very careful and thoughtful consideration and detailed estimates that the question can be satisfactorily decided. This is particularly true on the Menominee Range where perhaps the greatest variety of conditions are met with. It is often necessary to employ different methods in different parts of the same mine because of the rapidity with which changes in ore or wall rocks occur.

The iron mining districts of the Lake Superior region, together with the copper mines of the nearby Keeweenau Peninsula, have made large contributions to the art of mining in this country and have served as a field of experimentation and a school for mining men whose services have been in demand all over the world. Many of the methods developed here have been later used in other parts of the United States and in foreign countries where they have often been varied in detail to suit local conditions and perfected to a high degree of efficiency.

In the field of open-pit mining the Mesabi Range has pioneered in the development of methods and introduction of equipment, including the electric shovel and all-electric haulage in the pits.

Among the outstanding achievements in underground mining in this region during the past decade is the development of scraper loading or "slushing" to a high degree of efficiency. Here again, due to the wide range of conditions and the very different characteristics of the broken ores, no uniform method or standard equipment has been possible, and it has been necessary to develop different types, sizes, and weights of scrapers to be used in handling the different ores. It may be safely stated that had it not been for the development of efficient scraper-loading, many active underground mines could not have operated successfully during the past few years. From the standpoint of the workman, the scraper has enabled him to earn higher wages and has made his work much less arduous.

A class of officials in the bureau's advanced first aid and mine rescue course, Lake Superior District

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Ore District

SAFETY WORK

THE States of Minnesota and Wisconsin and the upper peninsular portion of Michigan have been designated as District E, one of the 10 districts into which the safety division of the United States Bureau of Mines has divided the United States for administrative purposes. This region is served by a safety division field office now located at Duluth, Minn., with a mining engineer in charge. One of the bureau's latest, most nearly up to date, and most fully equipped and manned steel mine-rescue cars is assigned to full time duty in District E; during the fiscal year ending June 30, 1929, approximately 1,300 mining men were given the Bureau of Mines complete course of instruction in first aid to the injured, or in the use of mine rescue apparatus, or were instructed in the advanced mine rescue course.

Over 950 persons, chiefly underground face workers, were given the full Bureau of Mines course in first aid to the injured during the past fiscal year in District E, and in addition nearly 200 others took part of this course. The bureau's personnel in District E is now trying to interest the mining people of that region in a relatively new practice in connection with first-aid work—that of giving first-aid training to the entire personnel (instead of a selected few) of mining plants, including surface as well as underground employes and bosses as well as workers; this is now being done to a considerable extent in coal mines of Illinois, Pennsylvania, West Virginia, Alabama, Colorado and other states. The mining companies assist the bureau instructors in "putting over" this type of work, and the resultant benefits have been found to include a greatly decreased accident occurrence among all employes, as well as saving of pain and in some instances of life.

During the past fiscal year the full course in mine rescue was taken by more than 250 persons, chiefly underground employes, in District E; and the advanced course in mine rescue, given only to officials to better enable them to prevent mine fires or to combat them should they occur, was taken by about 60 persons. The net result has been that although the Bureau of Mines car and its crew and equipment are available for service in case of mine fire, and although numerous fires have occurred in the iron mines of District E, the mining companies almost invariably handle their own fires and do it efficiently.

Right—Part of the training given by the bureau's instructors in the advanced mine rescue course includes the use of the telephone during mine fires

Left—Receiving instruction from Bureau of Mines' men in the use of the inhaler

At the International First Aid and Mine Rescue meet held at Kansas City, Mo., under the auspices of the United States Bureau of Mines and other organizations, 40 picked first-aid teams from 18 states participated; the team from Ironwood, Mich., representing Pickands, Mather & Company, took third prize; this was done in competition with "crack" teams representing not only the coal and metal mining industries, but also the petroleum and cement industries and nonmetallic (sulphur and fluorspar) mining. The Bureau of Mines representatives in District E cooperated with the safety and operating officials of Pickands, Mather & Company in training first-aid teams at the various plants of that company and in the holding of elimination meets from which the team was chosen that took the above-mentioned honors at Kansas City.

Ventilation Studies

For a number of years the Bureau of Mines has engaged part of its safety personnel in a study of ventilation of metal mines, and mines on all of the iron ranges of the Lake Superior region have been included in the study. This investigation has shown that metal-mine ventilation is very intimately, in fact almost inextricably, associated or involved with the occurrence of diseases such as miner's consumption, and also with fire prevention, fire fighting, and safety. Most of the mine examinations made in the ventilation study consisted of taking samples of mine air and samples of dust from mine air, making chemicalor microscopic analyses of these samples, and interpreting the results as to the effect of the air condition on health, efficiency, and safety. The reports gave details of mine-air conditions, including temperature, humidity, chemical and dust content, quantities flowing, probable conditions at time of or after mine fires, effect on decay of timber, and other pertinent data. Definite

recommendations were made as to a suitable ventilation system for every mine examined, including size and placement of fan, location of main doors, and suggestions as to planning and procedure for prevention of fires and in case of fire. In addition numerous accident hazards were pointed out and definite safety recommendations offered. Reports of the above type were made on several mines on all of the ranges, and in several instances many of the recommendations were put into use and almost invariably with ultimate benefit not only to the company but also to those employed in the mines.

Mine examinations and reports of essentially the type described are being made currently by Mining Engineer F. S. Crawford, now representing the Bureau of Mines in the Lake Superior region, with Duluth as headquarters. Mr. Crawford's experience, not only in metal mining but also in both bituminous and anthracite coal mining, should give him unusual advantages in the making of ventilation as well as safety reports; his coal-mining experience in particular should aid materially in his ventilation recommendations inasmuch as coal mines, through their peculiar natural hazards, require much more minute attention to ventilation than is generally throught necessary in metal mining. Since Mr. Crawford's start on his mine examination work in the Lake Superior region about January 1, 1929, he has submitted more than half a dozen complete safety or ventilation reports on as many mines on the iron ranges. These investigations and reports are available to any mine or mines desirous of having them; reports of this nature are confidential, hence are not published.

Another service which the Bureau of Mines is giving the iron mines of Minnesota, Michigan, and Wisconsin, as well as the mines of the United States as a whole, is that of assembling good or heroic safety records in cooperation with the J. A. Holmes Safety Association and the sponsors of the Sentinels of Safety trophy, with subsequent awarding of certificates or medals for meritorious performance in safety. In the past few years a hero award was made to Thomas Trewartha, of the Pabst mine. J. A. Holmes Association certificates of merit have been awarded the Bristol, Albany, Negaunee, Vulcan, and Dunwoody mines; and Sentinels of Safety trophies have been won by the Bristol mine in 1927 and by the Berkshire and Wakefield mines in 1928.

In cooperation with the Forest Products Laboratory, of Madison, Wis., and The Cleveland-Cliffs Iron Company, the Bureau of Mines has during the past few years aided in some experimental work being done in treating of mine timber by various substances and exposing them to various mine-air conditions in one of the mines of The Cleveland-Cliffs Iron Company. It is thought that data of value to the mining industry will ultimately be available from this study. In this connection it is of interest to note that at least one of the iron-ore mines of the Lake Superior region found that the introduction of controlled mechanical ventilation upon recommendation after a Bureau of Mines ventilation study resulted in greatly decreased decay of timber in its workings.

One of the functions of the Bureau of Mines engineering representation in the Lake Superior region has been that of forwarding the meetings of the Lake Superior section of the National Safety Council. There is no question that these annual meetings held usually at Duluth are probably as lively as any safety gatherings of metal-mining men held in any part of the United States. The bureau is pleased that its representatives of recent years in the Lake Superior region, Messrs. Pickard, Ageton, Carrick, Gregory, and Crawford, have been able to take a prominent part in the forwarding of these very excellent annual safety affairs.

While many very complete safety and ventilation reports have been formulated and copies sent to the operators on whose mines the investigations and reports were made, practically all of these reports have been confidential; relatively little has been published directly or indirectly by the Bureau of Mines concerning a really large amount of investigative work which it has done on health and safety in the iron-ore mines of the Lake Superior region. In June, 1928, an excellent paper by F. C. Gregory entitled "Fires and Fire Prevention in Lake Superior Mines" was published; the paper gave many data of interest to the entire mining industry, and conveyed the information without violating the confidence of any operator.

In the more or less near future the Bureau of Mines intends to assemble and publish data concerning much of the very excellent safety work being done on the iron ranges; the safety organizations and safety work done in the iron-ore mines of this region are excelled by similar work or results in no other region. Similarly, it is intended to abstract the wealth of available data on ventilation practice and requirements of the iron-ore mines of the Lake Superior district and issue it in published form; there is no question that ventilation practice is by no means as nearly up to date and efficient as is safety practice in this region.

The Manganiferous Iron Ores of Minnesota

MANGANESE plays an important role in the present art of steel-making because it is a superior deoxidizer and adds desirable physical properties to the finished steel. Most of the manganese consumed is in the form of ferromanganese, an alloy of iron and manganese made from high-grade ores.

Relatively little attention was paid to the domestic manganese situation prior to the World War. Before that time the necessary manganese ores were imported, largely from Russia and India. During the stress of war, however, interest in manganese became acute inasmuch as the metal was virtually indispensable in the manufacture of steel. Every effort was made to stimulate domestic production in view of threatening transportation difficulties.

Domestic ores of the grade now used for the production of ferromanganese (more than 35 percent Mn) are limited in amount, although low-grade ores (5 to 35 percent Mn) are abundant. The manganiferous iron ores of the Cuyuna district of Minnesota constitute an important source of these low-grade manganese ores.

The United States Bureau of Mines, through its North Central Experiment Station, at Minneapolis, Minn., in cooperation with the Minnesota School of Mines Experiment Station, therefore undertook a thorough study of pyrometallurgical methods for making ferromanganese from these ores.

Smelting of Manganiferous Iron Ores

Two types of manganiferous iron ore occur in Minnesota, brown and black. Due to its lower silica content, the brown ore, which is essentially an iron ore containing 5 to 10 percent of manganese, is best adapted for pyrometallurgical treatment. If its iron content is to be used in the production of steel the problem consists, then, in modifying the standard procedures for the production of pig iron and steel so that the manganese can be recovered.

Tests made with a 6-ton experimental blast furnace have proved the feasibility of smelting an ore burden made up entirely of the brown type of manganiferous iron ores. These analyzed from 6.7 to 12.6 percent manganese, 31 to 35 percent iron, 0.23 to 0.29 percent phosphorus, 4 to 13 percent silica, 3.5 to 7 percent alumina and had high moisture and ignition losses. The high alumina content of the ores, although it must be considered in burdening, does not seriously militate

against their smelting. About 150 tons of metal, containing 12 percent manganese, 4.5 percent carbon, 0.25 percent silicon, 0.55 percent phosphorus, and less than 0.01 percent sulphur, were produced.

Details of these tests are presented in "Minnesota Manganiferous Iron Ore in Relation to the Iron and Steel Industry," by T. L. Joseph and S. P. Kinney, University of Minnesota, Bulletin No. 12, 1927, 101 pages.

Separation of Manganese from Iron

Under present practice, sufficient manganiferous iron ore is added to the ore mixture of basic blast furnaces to produce pig iron containing 1.5 to 2.0 percent manganese. When this high-manganese pig iron is charged into the basic open-hearth furnace with about equal or slightly greater amounts of steel scrap, most of the manganese passes into the slag, which will contain from 5 to 10 percent MnO. By using a pig iron analyzing from 10 to 15 percent manganese, such as that produced from brown ore in the experimental blast furnace, the slag formed in the open-hearth furnace would contain much more manganese and could be used as a high-grade manganese ore. The United States Bureau of Mines therefore erected an experimental open-hearth furnace in order to ascertain the conditions under which the best results might be obtained.

The early experiments showed that in order to eliminate the manganese in the metal to below 1 percent, the iron oxide in the slag would have to equal about one-third the manganese oxide in the slag. Such a slag would not be suitable for use in making ferromanganese. The phosphorus content also was prohibitive. By spreading a layer of coke over the slag, the iron and phosphorus were reduced at a rate depending to a great extent upon the slag fluidity.

The heat may be divided into two periods, an oxidizing period and a reducing period. During the oxidizing period, manganese, silicon, and about one-half of the carbon are eliminated from the metal. By using enough iron ore to maintain about 30 percent of iron in the slag at the end of the oxidizing period, the manganese in the metal can be reduced to about one-half percent in an hour. By this time, the manganese oxide in the slag has increased to a slightly greater amount than the iron oxide. The phosphorus in the slag at the end of the oxidizing period is normally about 1 percent.

The oxidizing period is followed by a reducing period, during which a layer of coke or other reducing agent covers the slag. The oxides of iron and phosphorus are reduced from the slag at a much faster rate than the manganese. From 1½ to 2 hours are required for this period. If hot metal from a blast furnace were charged into a furnace for preliminary treatment to remove the manganese, 2.5 to 3 hours should be sufficient for both the oxidizing and reducing periods.

Typical results are shown in the following table, taken from "Production of Ferromanganese from Manganiferous Iron Ores," by T. L. Joseph, E. P. Barrett and C. E. Wood, Proceedings of the First Annual Convention, American Manganese Producers' Association, 1928, pages 49 to 56.

COMPOSITION OF SOME FINAL SLAGS MADE IN THE SMALL EXPERIMENTAL OPEN-HEARTH FURNACE

Run No.	Mn Percent	Fe Percent	P Percent	SiO_2 Percent
90	49.2	4.5	0.26	....
94	44.5	3.6	0.17	....
101	50.5	9.6	0.19	11.4
117	49.0	4.8	0.08	....
118	42.9	3.2	0.20	....
121	45.3	7.1	0.25	....
194	46.0	17.0	0.38	6.4
197	44.1	11.7	0.32	9.4
198	48.9	7.4	0.22	11.2
205	44.0	4.7	0.10	14.7
207	48.2	7.6	0.13	11.4
209	44.9	12.6	0.65	10.0
216	46.4	10.4	0.28	11.8
223	47.7	8.6	0.64	12.6
229	44.5	8.6	0.22	13.8

The most difficult problem of the process is to obtain a slag low in silica and at the same time to reduce rapidly the oxides of iron and phosphorus in the slag to within limits allowable for material from which to produce ferromanganese. At the time the coke is added the slag is very fluid, but as the ferrous oxide is reduced the slag begins to stiffen to a degree depending on the amount of silica present.

The successful completion of this problem will make the low-grade manganiferous iron ores of the Cuyuna district available as a raw material for the production of ferromanganese. The process is simple since it deviates but little from standard practice. Blast furnace treatment would be same as at present, the burden only being changed. Open hearth practice would be but little altered, as outlined above. The resulting slag would then be available as a high-grade manganese ore at but little cost.

MARKET RESULTS OF MERGERS

(*from page 793*)

iron ore reserves, the resulting combinations will secure adequate supplies of iron ore for a period of future years—possibly at the expense of the independent merchant furnace, that is less able to protect itself. At the same time, the amount and variety of ore that is available for such independent furnaces on the open market, is bound to be proportionately less, and it is entirely conceivable that it could become very small and the grades so available restricted in quality and variety, depending upon the extent to which the well entrenched producers are brought together through consolidations of the consumers.

It seems safe to say that as time goes on, the choice and tonnage of ore that is left available for the smaller steel works or the merchant furnaces or such future companies as may come into existence, will be materially less and the prices correspondingly higher. The outlook for the ore producer is a much more favorable one than that for the smaller or independent merchant furnace or steel works plant. The producer will find better markets for his product both from the standpoint of tonnage and price. The consumers, on the other hand, will almost certainly have less to choose from in the way of raw material and the price would seem bound to increase.

THE PIONEER FURNACE

(*from page 787*)

coal pig iron in foundry mixtures for products requiring a chilled surface for strength and hard resistance, wearing qualities such as crushers, grinding belts and dies; or steam and gas engine cylinder blocks, valves and other high grade castings provides a stronger, denser casting—free from breaks, blow holes, etc., easier, less costly to machine—and a better finish.

The following table gives the specifications of the various grades of charcoal iron produced:

	Sil. Avg.	Max.	Chilled
AA Scotch	2.62 and over		
A Scotch	2.38	2.50	2.62
B Scotch	2.13	2.25	2.37
C Scotch	1.88	2.00	2.12
Low 1	1.63	1.75	1.87
High 1	1.38	1.50	1.62
Low 2	1.13	1.25	1.37
High 2	.88	1.00	1.12
Low 3	.63	.75	.87 Trace to ¼ in.
High 3	.50	.56	.62 ¼ to ⅝ in.
Low 4	.38	.44	.50 ⅝ to 1 in.
High 4	.25	.32	.38 1 to 1½ in.
Low 5	.20	.25	.30 Low mottled
High 5	.10	.18	.25 White mottled
No. 6	.00	.00	.12 White
Phosphorus			.15 to .22
Manganese			.30 to 1.00
Sulphur			Trace to .025

COMMITTEE TO REVISE METAL MINE TRANSPORTATION STANDARDS

The Standardization Division of The American Mining Congress announces that the American recommended practice for underground transportation in metal mines, approved in May, 1928, by the American Standards Association, is to be revised and expanded by its committee having the matter in charge, under the chairmanship of W. W. Graff, superintendent of the Negaunee, Mich., district of The Cleveland-Cliffs Iron Co. The committee is being enlarged to represent all of the principal metal mining districts and the following classifications of interests: operators, consulting engineers, manufacturers, interested associations, and the Government.

THE MESABI IRON RANGE

(*from page 792*)

ore production in Minnesota. The following table gives the gross amounts and the average tax cost per ton for the period from 1921 to 1927, inclusive:

	Gross Amount of Tax	Average Tax Cost per Ton
Ad valorem	$18,309,881	$0.536
Occupational	3,127,165	0.093
Royalty	919,241*	0.019
Total taxes	$22,093,647	$0.648

* Average for the five years since this tax went into effect.

Taxation of iron ore in Minnesota has reached a point where it is highly burdensome to the operators and has been the subject of many vigorous protests on their part; in fact, the tax situation has had a very discouraging effect upon exploration for new ore and the development of known ore, unless it can be mined quickly and cheaply, which means by open pit methods.

Beneficiation of Mesabi Range Ores

While the Mesabi Range has vast reserves of direct shipping ore, there is a very large tonnage of ore material which, in its crude state, is not merchantable and must be beneficiated by some method before treatment. There are at the present time 32 beneficiating plants on the range, of which 24 are in operation. The following statement shows the method of treatment, tonnage so treated and percentage of total Mesabi Range shipments for 1928:

Method	Tonnage	Percent of Total Mesabi Shipment
Screening and crushing	8,076,300	22.8
Washing	5,151,100	14.6
Jigging	106,400	.3
Drying	9,500	.03
Total	13,343,300	37.7

Screening and crushing is done to remove large blocky taconite and to free ore adhering to pieces of rock. Washing removes fine sand and decomposed taconite. Jigging eliminates broken taconite from wash ore concentrates which otherwise would be too high in silica. Drying reduces the hydroscopic and atmospheric moisture content.

At the extreme eastern end of the Mesabi Range, as noted before, are vast deposits of magnetic ore formation in which the iron occurs as finely disseminated magnetite.

In 1920, after much experimentation, the Jackling, Hayden, Stone interests built a plant at large cost about 18 miles northeast of Mesaba Station for the concentration of this magnetic ore material. The steps in the operation were crushing, screening, fine grinding in ball mills, magnetic separation, filtering and sintering the filter cake.

The resultant concentrate is very high grade, low in phosphorus and moisture content. The operation was metallurgically but not financially successful due to the present condition of the iron ore market.

Wash Ore

The wash ores of the western end of the range may be more or less definitely divided into the three following classes:

(1) *First Grade Wash Ore:* A mixture of iron ore and silica in the form of fine sand. In this type of wash ore the iron ore occurs as small chunks and granules with sand seams in rather well defined alternating layers. The ore breaks up well in mining and the sand particles are easily screened and washed out, leaving a high grade concentrate.

(2) *Second Grade Wash Ore:* Wash ores of this type contain a large amount of sandy material and are, for the most part, found directly under the paint rock layer. In these ores the layers are not as well defined and there is often present a considerable amount of decomposed taconite which does not wash out as readily as the silica sand in first wash ore. While recovery of iron is lower in this class of ore, the concentrate is of good grade if there is not too much decomposed taconite present.

(3) *Third Grade Wash Ore:* This class of wash ore contains, besides the layer of fine iron ore and sand, more or less decomposed taconite and thin layers of taconite. Washing alone will not remove the pieces of taconite and the intermediate-sized concentrate is jigged to remove the taconite. Naturally, iron recovery is lower but a good grade of concentrate is produced.

It is quite easy to properly classify a first grade wash ore, but with the second and third grade wash ores, tests are desirable to determine iron recovery and quality of concentrate.

Figure 5 shows the flow-sheet of an up-to-date washing plant where jigging may be employed when necessary. Jigging in connection with the concentration of Mesabi wash ore is being done for the first time this year and will unquestionably come into more general use, greatly increasing the reserves of ore material amenable to concentration.

The average wash ore concentrate is desirable from the furnace man's standpoint in that it is usually of good coarse structure without too much fines and of fairly uniform analysis.

Mining men from all parts of the world visit the Mesabi Range to study its open pit mining operations and to marvel at the size, equipment and efficiency.

I wish to acknowledge indebtedness to the Minnesota State Tax Commission for many of the statistics given.

FACTORS IN PRODUCTION OF SPONGE IRON

The idea of "direct processes" for the production of iron and steel from the ore has persisted throughout the history of ferrous metallurgy, says the United States Bureau of Mines. The production of steel from sponge iron has theoretical advantages over the present-day standard methods, and hundreds of so-called "direct processes" have been proposed or tried during the past century.

Iron oxides, when reduced at temperatures below 900° C., form a dark gray substance, very porous but otherwise in almost the same form as the original particles. In the temperature range of 1,000 to 1,100° the product is partly sintered but still shows the outlines of the original particles. These products are known as "sponge iron." At temperatures of 1,100 to 1,200° the metallic iron begins to flow together into a semi-fused, pasty, porous mass called a "bloom," which can be worked under a hammer to form a product similar to wrought iron; it contains slag inclusions and is too low in carbon to make steel. If the temperature is 1,200 to 1,300°, part of the iron will fuse enough to absorb more carbon. The dissolved carbon lowers the melting point and still more carbon is absorbed. The melted portion acts as a flux for the unmelted metallic particles until the entire mass becomes a high-carbon fluid known as "cast iron."

Sponge iron was probably the form in which the first iron was recovered from the ores. As early as the eighth century the Catlan forge developed into a low-shaft furnace known as the "high bloomary," in which iron was produced in the form of a pasty mass. In 1340 the first blast furnace was built in Belgium. The greater part of the iron was made into wrought-iron blooms by crude puddling processes. Charcoal was used as the fuel until the latter part of the seventeenth century when coke was used in England. In 1865 Bessemer built his first converter in England, and within a few years the Siemen's regenerative open-hearth furnace was developed, also in England. Enormous expansion in the metallurgy of iron followed.

In Serial 2955, by Edward P. Barrett, just published by the Bureau of Mines, some important factors in the production of sponge iron are outlined. Iron oxides may be reduced by heating with either gaseous or solid reducing agents, Mr. Barrett points out. The reduction of iron oxides to metallic iron is a step-by-step process. The various steps in both the gaseous reduction process and the ore-solid process are outlined in the paper.

SCHOOL of MINES of the University of West Virginia

By C. E. LAWALL *

Located in one of the most important coal mining districts in the country, this school has splendid opportunity to serve the industry effectively — Mining Extension Department — Bureau of Mine Research

COAL is an essential West Virginia industry, being of prime importance from the standpoint of its magnitude and of its industrial value. It is West Virginia's greatest industry being of vital importance to about 500,000 men, women and children in the state. All the people in many towns of the state are dependent almost solely upon coal for a livelihood.

West Virginia has a total of 117 coal seams, 52 of which are of sufficient thickness to be classified as minable. The coal area of the state includes 9,500 square miles with an estimated original coal supply of 60,800,000,000 short tons and much of this is the finest fuel in the United States.

In 1927 the coal produced in the state amounted to 146,088,121 short tons. The total value of this coal was $245,428,043.28.

Seven hundred and sixty-six companies operating 1,159 mines, and employing 119,618 men mined this tonnage.

In other words, 119,618 men in West Virginia in 1927 mined the equivalent of a block of coal 6 ft. high with a surface area of 13,759 acres or 21.5 square miles. This is a comprehensive picture of the magnitude of mining work in the state which each year produces over one-fourth of the annual production of bituminous coal in the United States. Here, nestled in the hills in the center of the coal producing area of the country, is the School of Mines of West Virginia.

The School of Mines of West Virginia University on which rests the responsibility of providing educational facilities for the mining men of the state is composed of three departments: the Mining Engineering Department; the Mining Extension Department, and the Bureau of Mine Research.

The Circle, with Woodburn Hall in the background

THE MINING ENGINEERING DEPARTMENT

The Mining Engineering Department is the department of the Mining School that offers a four-year degree course in mining engineering, and a four-year degree course in oil and gas engineering. The mining department is distinctive in that it specializes in the science of bituminous coal mining.

The history of the school goes back to 1887 when T. M. Jackson was made professor of the School of Civil and Mining Engineering. Professor Jackson was very much interested in the development of coal lands in the state and offered a course in mining with Ihlseng's Manual of Mining as the textbook. This course was given for eight years and was discontinued chiefly because the professors of civil engineering succeeding Professor Jackson had little or no knowledge of mining.

In 1906 largely through the efforts of Mr. J. B. Finley, a member of the Board of Regents and Dean C. R. Jones then Professor of Mechanical Engineering, an independent department of mining engineering was established and a four-year course leading to the degree of Bachelor of Science in Mining Engineering was put in the curriculum. Unquestionably, the increasing production of coal in the state, which in this year amounted to 41,891,890 short tons had much to do with the decision to establish an independent mining department at the University and also because many students coming to the Engineering College were interested in mining courses.

In 1907, Henry Mace Payne was appointed Professor of Mining Engineering. He was succeeded by Professor R. B. Brinsmade in 1910. In 1911 Professor Brinsmade resigned.

In 1912, Professor E. N. Zern was appointed head of the department and under his leadership the mining engineering developed rapidly. During his administration the Short Course in Coal Mining was started in 1913; the Mining Extension movement in the state was started in 1914; the Vocational two-year course in mining was started in 1913, and the course in Oil and Gas Engineering was started in 1915. Professor Zern wrote a series of bulletins on mining which were published as bulletins of the College of Engineering and in addition he did a great deal of work among the mining men throughout the state, so that his administration is marked as one of great activity and expansion of the mining department.

* Head, School of Mines, West Virginia University.

Model room with small mine fan and ventilation models in center, Oldham gas testing machine on the right, and models of an oil derrick and a Phillips crossover dump.

tations a week. The 15 units required must include—one and a half units of algebra, one unit of plane geometry, one-half unit of solid geometry, four units of English and two units in each of two other subjects.

After a student enters the University he is required to take a mental-alertness test and these data are available to his class advisor for inspection. It is obvious that a candidate for a degree in mining engineering should be endowed with abilities that are peculiarly essential to this occupation and if he does not possess these he should know about it

The coal laboratory, fully equipped for all analytical work on coal and coal products, showing gas apparatus in rear and Parr and Emerson calorimeters on right.

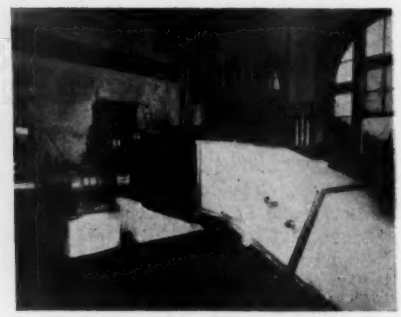
The mining laboratory, showing Butchart table and Hartz jig on right.

Forge shop where the mining students learn the fundamentals of forging.

The foundry with cupola in background.

Corner of oil laboratory, showing experimental petroleum still with fractionating column and condensers in foreground and Brown still and evaporating kettles to left.

A corner in the mining laboratory with bituminous spiral separator in the foreground and crushers and rolls in the rear.



Ventilation laboratory, showing Jeffrey reversible fan connected to a General Electric brush shifting motor with a Link-Belt silent chain drive.

Professor Zern resigned from the department in 1917 and was succeeded by Professor A. C. Callen. The department continued to grow under Professor Callen's administration and he enlarged and expanded the work of the mining engineering and extension departments. He resigned in 1924 to become Professor of Mining Engineering at the University of Illinois.

Requirements for Admission

Students entering the College of Engineering must offer 15 units of credit from a standard high school or a fully accredited preparatory school. A unit of credit represents a year's high school work in a single subject, with five recitations a week. The 15 units required must include—one and a half units of algebra, one unit of plane geometry, one-half unit of solid geometry, four units of English and two units in each of two other subjects.

After a student enters the University he is required to take a mental-alertness test and these data are available to his class advisor for inspection. It is obvious that a candidate for a degree in mining engineering should be endowed with abilities that are peculiarly essential to this occupation and if he does not possess these he should know about it during his freshman year so that he can make a change to another course.

Mining Engineering Curriculum

During the first two years of the course in mining engineering, the student is given a thorough training in the underlying principles of mathematics, chemistry and physics. Supplementing these are courses in surveying, including mine surveying, drawing, mineralogy, geology, English, and shop work. In the last two years of the course two options are provided, one in coal mining and the other in oil and gas engineering. The student is permitted to make his choice of either of these courses at the beginning of the sophomore year.

In the coal mining option course the student specializes in mining subjects in the third year. These studies include, mining methods, with special emphasis on mechanization, geology and classification of coals, explosives and blasting, drilling, prospecting, shaft-sinking, haulage, hoisting, drainage and pumping. The course in mining design in the senior year, consists in the projection of mine workings and design of mining plants and tipples. Thorough courses are given in mine gases, safety lamps, mine ventilation, coal preparation, with laboratory studies of the washability characteristics of certain coals, and emphasis is placed upon principles and methods of modern coal cleaning devices. Courses in fuels, mine management, eco-

nomics, chemistry, electrical engineering, metallurgy, theoretical and applied mechanics, hydraulics, structures and mechanical engineering give the student the necessary training to deal effectively with engineering problems.

The oil and gas option course is planned to give the student a knowledge of the fundamentals of mining but special emphasis is put on geological and oil and gas engineering studies. Courses in oil and gas production, oil refining, oil laboratory, geological surveying, structural geology, and fuels are among the specialized courses offered during the third and fourth years.

Teaching Staff

The teaching staff in the School of Mines is composed of men who have spent considerable time in the industry and as Morgantown is in the center of a large mining field, they are able to keep in close touch with the ever changing conditions in the industry.

Since all the instructors have had considerable industrial and mining experience, the student's training here is in the form of an apprenticeship to the older engineer who inculcates in him the principles and underlying science of his profession so that during his college course he does not accumulate mere facts but receives that substantial training and grounding in fundamentals that makes for efficiency in engineering work.

Location of School of Mines

For students in coal mining engineering the location of the School of Mines is unusually favorable, offering the student many opportunities for practical education and observation in engineering work. Morgantown is in the center of one of the richest and most extensive mining regions of the state, in which large mines are working in the Pittsburgh, Sewickley and Upper Freeport seams. The University is within easy access of shaft, slope and drift mines and with outcrops of the coal measures in all the surrounding hills, the student here finds a veritable natural coal mining laboratory at the University's backdoor.

The region abounds in deposits of glass sand, limestone, brick and fire clays, millstones and valuable building stones. Within the city or in nearby towns are numerous factories and manufacturing plants including large central electric power stations, cement plants, tin plate mills, glass factories, manufacturing glass of every description, brick plants, by-product and bee-hive coking plants, brass and iron foundries, large oil and gas pumping and compressor stations and limestone mines, quarries and crushing plants. Connellsville is only 43 miles from Morgantown and Pittsburgh, the center of the world's greatest iron and steel industries is only 80 miles distant.

Inspection Trips and Outside Work

At West Virginia the engineering students are required to correlate practical work with the academic work. The faculty insists that they supplement the class training by personal contacts with actual operating conditions and the factors that influence them. All candidates for degrees in engineering must spend at least six weeks during a vacation period in some branch of engineering activity, preferably in work relating to his major subject for which two hours of college credit is given and these credits are required for graduation. Students are recommended to spend all their vacation periods in practical work because the art of mining can best be learned in the mines, but the science of mining can be learned best in the colleges.

C. E. Lawall, Head of the School of Mines.

The mining students also make a number of trips to nearby mines in connection with their courses in mining methods and mine surveying, and during their senior year are required to take an inspection trip, lasting a week, to mines and plants throughout the state.

The illustrations of the mining and chemical laboratories give some idea of the equipment and facilities of the School of Mines. The mining laboratory is equipped with a Blake crusher, Jeffrey bucket elevator, a 24-in. shaking screen and a 30-in. trommel screen, also rolls, jigs, a Butchart table, a Jeffrey-Robinson coal washer, a bituminous spiral separator, a deletester for washability studies of coal and all other necessary equipment to run laboratory coal washing experiments.

One of the campus beauty spots.

The ventilation laboratory has a Jeffrey reversible mine fan, coupled to a brushing shifting motor by a Link-Belt Silent chain drive. The coal laboratory is equipped with fuel calorimeters, electric furnaces, and hot plates and all the necessary apparatus for making coal and gas analyses. The school has well equipped laboratories to carry on studies relating to coal and coke.

The Mining Extension Department

The Mining Extension Department is the department that carries on mining educational work among the mining men of the state. This work is directed chiefly to aid men who are already employed in the mining industry and who need to supplement their experience with more accurate technical training. The mining extension movement in West Virginia is based on the principle that "it is the duty of the state through one of its established agencies to extend an opportunity for educational betterment to those who, in their earlier years, have failed, by reason of adverse environment to acquire a common school education."

An intimate knowledge of the mining regions of the state reveals the need for mining extension work such as the mining extension department is carrying on, and the unusual success that this department has had, in bringing to the mining men a more thorough understanding of their problems, has established this work throughout the state, and emphasizes the point that the mining men are beginning to understand that education does not stop with school or college days, but that one must be a close student of the progress and changes of his vocation if continued success is to be assured. This department has widened the period for miners, who left school at an early age to obtain a formal education and over 1,000 men each year are availing themselves of this opportunity.

That the men of the coal industry are eager to learn more about the whys of things, and are interested in advancing themselves in their vocations is attested by the fact that during this past year 1,186 men were enrolled in the mining extension department. Of these 1,186 men 7.25 percent were under the age of 20; 36.09 percent were between the ages of 20 to 30 years; 38.35 percent were

between the ages of 30 to 40 years, and 18.31 percent were over the age of 40 years. These figures clearly indicate that this department is reaching those students for whom it was primarily intended, and sets forth that this department is an important factor in the adult education program of the state. The example of nearly 1,200 mining men studying diligently night after night in the mining extension department throughout the school year to obtain an education, will impress you with the importance of this type of work.

During the past year, Foreman Development classes were taught at five places in the state. This is a significant trend in mining education. It means that the coal industry is beginning to cultivate a more skillful understanding of management problems on the part of its minor executives, and is insisting on more management per man than ever before. The request for this type of training came from several operator associations over the state and the mining extension department now has the staff and equipment to carry on this type of educational work.

Short Course in Coal Mining

The six weeks' course in coal mining given every summer at the University reaches the men that are unable to attend the regular extension classes held throughout the school year. It is impossible with our limited department to conduct mining extension classes in every mining community, and although classes were conducted at 39 different places last year, yet there were many demands for classes that could not be satisfied. The short course provides an excellent opportunity for the ambitious mining men to come to the University during the summer and obtain the training necessary for advancement. With all the facilities and equipment of the University available to these men, this course is made rather intensive, and more advanced than the regular field courses. The associations that the students make, and the habit of study they develop during their six weeks' stay at the University are important factors in this work.

Bureau of Mine Research

The Bureau of Mine Research has for its purpose the conducting of investigations and making tests to better safeguard the lives of miners and to bring about greater efficiency and conservation in the mining and mineral industries, to make such tests and investigations as may be required by the department of mines, to conduct such experiments and tests as may promote the development of the mineral industries of the state and to cooperate with the department of mines in the investigation of the cause of mine disasters and common mine accidents.

Mechanical Hall, occupied by the Departments of Engineering and by the School of Mines.

In general the object of the mining experiment station is to make available to the State Department of Mines both the staff and the equipment of the School of Mines for the study or investigations of all mining problems that will promote the welfare of the mineral industries of the state.

Graduates and Research Work

Important progress is being made in the graduate and research work of the School of Mines. Never before in the history of the coal industry has it been so necessary to develop and devise new methods for the utilization and burning of coal. The industry is advancing at such a rapid rate that it can not afford to ignore the fruitful results that scientific studies of coal will bring forth, but the industry spends a very small amount of money per ton of coal produced to develop the potential value of this valuable raw material. We try to stimulate an interest in research work at the School of Mines and each year have graduate students working on special problems relating to coal.

At present there are two graduate students in the mining school doing research work. One in the field of mining, and the other in the field of coal carbonization work, this work will lead to the degree, master of science, for the students.

One student is making a study of mine haulage systems in the state. The results of this study will be published as a bulletin of the University with suggestions and recommendations on modern mine haulage systems brought out by the study.

The other graduate student is investigating the properties of seven typical West Virginia coking coals, extending from the Pittsburgh coal in the northern part of the state to the Pocahontas coals in the southern part of the state. This investigation will include the study of the composition of the coal, the composition of the ash, fusing point of the ash and possible by-product values and yields of these coals, and the results of this study will later be published as a University bulletin.

Two graduate students working with the head of the School of Mines last year made a study of Mining Methods in West Virginia. This was a study of all the typical methods of mining used in the state, including the performance record of each system and the advantages and disadvantages of each system under different conditions of mining. This bulletin is now being printed and will be distributed as soon as it is received from the press.

During the past year the School of Mines has been very much interested in getting vocational mining courses taught in the high schools in certain coal producing districts. The purpose of this work is to adapt high school vocational courses to the industrial needs of the community. Coal mining courses included in the list of optional courses offered in the high school situated in mining communities will probably get some boys interested in the state's most valuable and important industry, and if these courses are taught properly they will be of inestimable value to those boys who later decide to take up mining work as their vocation.

The high schools at Berwind and Gary, W. Va., have just completed work of this kind and other high schools will start this type of work this year. This work will certainly impress the boys with the importance of the coal industry to the state and the relation of the coal industry to the other industries and will give them a new attitude toward mining work.

The School of Mines of West Virginia University tries to satisfy all claims that the coal industry of the state places upon it. Through its faculty and equipment it stands ready to help the mining industry in any way that it can. If the industry wants to establish research scholarship in mining or fuel technology we have the staff and equipment to aid them, if they want to use the equipment of the school for any special research work it is available to them for we feel that the more service the school can be to the industry the more it is fulfilling its duties.

LEGISLATIVE Review

Senate begins consideration of tariff revision bill—Calls on Treasury Department for income tax data to determine whether rates are justified—Legislation proposed to grant public lands to the states

THE Senate is in the thick of a fight over the tariff revision bill, although leaders in charge of the legislative program are hopeful of disposing of the measure before the regular session of Congress begins December 3. Reversing the former order of procedure, the Senate, on suggestion of Democratic leaders, first considered the special and administrative features of the measure, deferring until a later time the rate and free list schedules. Consideration of the measure was begun by the Senate on September 9, and the prospective fight over whether the revision should be confined to agricultural products did not materialize, the opponents of the measure confining their opposition to a general attack on the bill as a whole and the flexible provisions in particular. Little time was wasted in the usual opening series of prepared addresses on the tariff, and the Senate immediately proceeded to act on the committee amendments.

A new feature in tariff legislation was injected by the Democrats when they forced the adoption of the resolution calling on the Treasury Department to make available to the Finance Committee information as to profits or losses, costs of production, and wages paid by industries affected by the tariff bill. The leading members of the committee have decided not to give out the names of these companies and information thereon furnished by the Treasury Department unless directed by a vote of the committee on the ground that to do so would be to violate the secrecy of income tax returns.

Another bill of particular interest to the mining industry which has come before Congress since the Senate reconvened on August 19 after its recess of two months, is a bill by Senator King, of Utah, to turn over the public lands and their resources to the states, and to establish a branch of the Interior Department in one of those states to which would be transferred the Bureau of Mines, Geological Survey and General Land Office. The House will not reconvene until October 14 for the transaction of business.

The following is a summary of recent legislation before the Senate:

Tax Returns

S. Res. 108, by Mr. Simmons (Dem., N. C.)—This resolution, which was adopted by the Senate, provides for inspection of income tax returns by the Finance Committee in connection with consideration of the pending tariff bill. The resolution is as follows:

That the Committee on Finance is directed forthwith to request the Secretary of the Treasury, pursuant to the authority vested in it under the internal revenue laws, to furnish the committee, at the earliest practicable date, a statement in detail for each of the taxable years 1922 to 1928, inclusive, of the profits or losses, as the case may be, and a separate statement for each of said years of each of the following items:

Gross sales from trading or manufacturing less goods returned, and any allowances or discounts from the sale price, and

(a) Inventory at beginning and close of each year;

(b) Merchandise bought for sale for each year;

(c) Cost of manufacturing or otherwise producing goods, separately (1) salaries and wages exclusive of compensation of officers, (2) material and supplies, and (3) compensation of officers, of the taxpayers whose names the committee, or the majority or minority members thereof, may from time to time during the consideration by the Congress of the pending tariff legislation transmit to the Secretary as being the names of taxpapers whose business is, in the opinion of the committee, or of the majority or minority members thereof, affected by the pending tariff legislation—in so far as such profits or losses are contained in or shown by the income tax and capital stock returns of such taxpayers, segregated, so far as may be practicable, to show the profits or losses, as the case may be, in the several branches or departments of the business of such taxpayers.

S. Res. 113, by Mr. McMaster (Rep., S. Dak.)—This resolution proposed to make available to Senators data from the Tariff Commission on the pending tariff bill. The resolution is as follows:

That on request of any Senator, the Finance Committee of the Senate is hereby directed to obtain from the Tariff Commission complete and full information, whether confidential or otherwise, within its possession, pertaining to any subject matter contained in House bill 2667, entitled "An act to provide revenue, to regulate commerce with foreign countries, to encourage the industries of the United States, to protect American labor, and for other purposes." All such information so obtained shall be accessible to each Senator.

S. J. Res. 68, by Mr. Blaine (Rep., Wis.)—This resolution proposed to suspend the secrecy of income tax returns during consideration of the tariff bill.

Public Lands

S. 1593, Mr. King (Dem., Utah)—This bill proposes to grant the unreserved and unappropriated public lands to the states. Such lands and the proceeds from their sale, lease or other disposition shall be used by the states for the support of their public institutions as their legislatures may determine. The act shall not apply to any public lands (1) included within any military or Indian reservation; (2) with respect to which any suit or proceeding is pending on the date of the approval of this act in any court of the United States; or (3) with respect to which any entry or application therefor has been made, or any right or claim has been initiated, under the provisions of law in force on the date of the approval of this act. Upon the restoration to the public domain of any lands excepted in clause (1) of this subdivision, or if, upon the determination of a suit or proceeding under clause (2) of this subdivision, title to the lands involved therein is in the United States, or upon the relinquishment or cancellation of any entry, application, right, or claim to lands excepted under clause (3) of this subdivision, such lands shall become immediately subject to the provisions of this act.

The grant made by this act shall be subject to the right of the holders of outstanding land certificates or scrip to locate such certificates or scrip in accordance with the provisions of law in force on the date of the approval of this act upon lands herein granted so long as the title to such lands remains in the particular state to which they are granted by this act.

The act will take effect when the state legislatures accept the grant, but such acceptance must be within four years after approval of this act. The bill will not apply to territories or possessions of the United States. On receipt of notice of acceptance from any state, the Interior Department will deliver to the state such maps, records, (*Continued on page* 818)

New Basis for Mine Depletion Allowance Recommended

Report of investigators to Joint Congressional Committee on Internal Revenue Taxation recommends new basis of allowance—Percentage of net income adjusted to allocate reasonable amount of income to plant investment—Coal industry said to receive less depletion than warranted

SEVERAL methods for computing depletion allowances to the mining industry are proposed for consideration by the Joint Congressional Committee on Internal Revenue Taxation in a report to it by L. H. Parker, chief of its Division of Investigation, made public September 23 for purposes of information and discussion. The depletion methods suggested are: Fixed rates per unit, percentage of gross income, percentage of net income. It is stated that the percentage of net income method will result in elimination of discovery depletion and partial elimination of March 1, 1913, valuation; stability of revenue from this source; correction of inequities between different industries and between taxpayers in the same industry; and simplification of administration.

The report states that the distribution of depletion allowances among taxpayers in the mining industry is inequitable, the allowances being excessive in some instances; that the present depletion system lacks certainty, and is expensive to the Government and to taxpayers. "The present depletion allowances depend in each case almost entirely upon certain factors and conditions which would appear to have very little if any relationship to the computation of a fair annual income at the present time," says the report. "In proposing new plans for the determination of depletion, the view has been taken that it is important to have taxpayers similarly situated pay the same rate of tax so that they may compete with each other without disadvantage as far as Federal taxes are concerned. Under the present system some taxpayers pay high taxes and others are practically tax exempt. The methods of percentage depletion proposed are not such a departure from the present system as would appear from preliminary inspection. The analytic methods of valuation now used in most important cases arrive at a value through the estimation of future expected profits. Depletion based on a percentage of the net income from the property merely use actual figures instead of estimates."

The report points out that the difficulties confronting the Internal Revenue Bureau in the valuation of natural resources are almost insurmountable as the present methods of valuation allow wide discretion in individual judgment, resulting in differences of opinion even with respect to the same properties. "Many actual cases exist in which experienced engineers have differed in their reports on the same property by at least 400 percent," says the report. "The date of valuation is so far removed from the date when the examination must be made, that it is practically impossible to secure sufficient evidence to determine a correct valuation. The turnover of personnel in the bureau and the magnitude of the undertaking have added to the difficulties." Mr. Parker states that the proposed plan for the percentage of depletion will eliminate, at least partially, the difficulties and inequities arising under the present system. He states that it has been impracticable to assemble sufficient data at this time to make a complete test of the soundness of the new principles applying to the depletion, and suggests that taxpayers analyze and apply them to their individual cases.

Property Cost

"From an accounting standpoint, the proper basis for determining depletion is the cost of the property," says Mr. Parker, but he does not recommend this basis because "of the apparent hardships resulting from its application." As each of the three methods of valuation now in use by the bureau are based upon different principles the report says they do not produce the same results. Analyzing the defects in the present system, the report states that the administration of the depletion allowance is lacking in uniformity in computing depletion due to the exercise of individual judgment, lapse of time between the basic date and examination of the tax return, inability to secure sufficient evidence to establish a correct valuation, and excessive expense to the Government and taxpayer.

In pointing out that the present system leads to instability of revenue, the report states that depletion of deduction is now allowed before arriving at income. "In lean years the present depletion allowances practically wipe out the tax of this industry, in spite of the fact that substantial dividends are paid, while in prosperous years high taxes are collected," says the report. "As a result, the revenue received from the industry is more unstable than in the case of other industries, which is undesirable from a practical revenue standpoint. The different laws relating to depletion as applied to different industries are not uniform. The oil and gas industry is allowed percentage depletion based on gross income before the deduction is computed. The effect is to vary the deduction in proportion to gross receipts from sales. Contrasted with this are the allowances based on 1913 or discovery value in which cases the depletion varies with the quantity produced. In certain limiting cases, depletion is allowed on a percentage of net income. Valuation methods applied by the bureau and taxpayer are not uniform and produce inequalities between different industries. Taxpayers who make discoveries in periods of prosperity are allowed large deductions while those who are unfortunate in making discoveries in years of depression are required throughout the life of the property to take a lower rate."

Plans Outlined

Two plans for applying depletion on the basis of percentage of net income are suggested as follows: (1) percentage of net income from the property, which is similar to the Canadian system; (2) percentage of net income adjusted to allocate a reasonable amount of such net income to plant investment. It is said the last plan, when applied to concrete cases, appears to produce more equitable results than the first.

In illustrating administrative difficulties and defects in the present system, the report gives figures showing the separate valuation of ten copper companies, who were given a total valuation of $950,537,647 by one engineer and $167,989,773 by another. Analyzing all corporations from 1922 to (*Continued on page* 818)

Mechanization Report No. 29-3

The Haulage Factor in Mechanical Loading

By G. B. SOUTHWARD

Formula and curves showing relation between loading machine production, mine car capacity and time of car changes

SINCE the first introduction of mechanical loaders, it has become recognized that their operating capacity is dependent on a number of factors outside of the loading rate of the machine. The chief of these factors is the mine car transportation and it will be the purpose of this article to analyze and show how the various phases of transportation affect the productive loading capacity. This discussion will be confined entirely to transportation and the other operations such as shooting, snubbing and shearing will not be taken into account at this time.

Loading machines are used in two systems of mining, room-and-pillar and long face. In long face mining, theoretically at least, the transportation problem is comparatively simple as it consists in placing and moving the cars in a solid trip on a track parallel to the working face. In this case the principal delay is in changing the mine car trips. In room-and-pillar work, there are three sources of transportation delays; *first*, the time required for shifting single cars to the loading machine at the working face; *second*, the time lost in changing gathering trips; and *third*, the time lost in moving the loading unit from one room to another. These three operations all have a separate effect on the productive capacity of the unit and the following discussion will deal primarily with the question of single car delivery to a loading machine.

Each type of mechanical loader has a certain rated loading capacity at which it will perform but the actual productive rate of a mechanical loading unit is not equal to the machine capacity unless the loader is operating continuously, discharging onto a conveyor or into a trip of mine cars. For instance, a machine may actually load a two-ton mine car in one minute but if the haulage delays are such that only 30 cars are loaded in one hour, then the operating or effective rate of the machine during that time is only one ton per minute. Obviously, therefore, the productive rate of a mechanical loading unit is the actual tonnage which is loaded.

This actual tonnage which is loaded is dependent on three major features—(1), the loading rate of the machine; (2), the capacity of the mine car; and (3) the time that the loading machine is idle. Each of these has a certain effect on the productive rate of the loading unit and it is evident that this rate can be increased by increasing the loading rate of the machine, by increasing the capacity of the mine car or by decreasing the time that the loading machine is idle. However, the changes effected in the productive rate do not vary in exact ratio to the changes made in any of these three factors and it will not necessarily double the output of the operating unit, to double either the machine loading rate or the capacity of the mine car or to halve the time that the machine is idle. The relation which does exist between these three factors and the productive loading rate, while not proportional, is definite and when mine cars are delivered one at a time to a loading operation, this relation can be expressed and calculated by the equation shown below. This is not submitted with the idea of attempting to reduce mechanical loading to a mathematical formula but it is submitted to show, theoretically, how the various phases of transportation affect the efficiency of a mechanical loading unit.

The three variables in this formula each have several values within the customary range of operation; loading machine rates vary from one to three tons per minute, mine car capacities vary from one to six tons and the time required for single car changes is from two minutes to half a minute. The theoretical productive capacity of a loading unit with any desired combination of these operating factors can be calculated from this formula but the relation between them can be more clearly seen when shown graphically as in *Figures 1, 2 and 3*. These show that changes in these operating factors will effect material increases in the tonnage loaded but they also indicate that there is an economic limit for each one of these factors beyond which any further gain in production should be made by changes in one or both of the others.

The limits within which each of these factors provide the greatest degree of efficiency for the operation is indicated in the curves in *Figures 4 and 5*. *Figure 4*

When a loading machine is at a working face, operating at a uniform rate and loading into mine cars which are delivered and placed one at a time: then—

(1) $$\text{Production Capacity (in tons per minute)} = \frac{\text{Mine Car Capacity (tons)}}{\text{Time of one car loading cycle (minutes)}}$$

Example—If the mine cars have a capacity of 2 tons, and if a loaded car is being taken away from the machine once every 3 minutes, then the productive capacity of the operation is 2/3 tons per minute.

(2) Car Loading Cycle = Time of Loading One Car + Time of One Car Change.

(3) $$\text{Time of Loading One Car} = \frac{\text{Mine Car Capacity (tons)}}{\text{Loading Machine Rate (tons per minute)}}$$

(4) From (2) and (3)

$$\text{Car Loading Cycle} = \frac{\text{Mine Car Capacity}}{\text{Loading Machine Rate}} + \text{Time of Car Change.}$$

THEN from (1) and (4)

$$\text{PRODUCTION CAPACITY (in tons per minute)} = \frac{\text{MINE CAR CAPACITY}}{\frac{\text{MINE CAR CAPACITY}}{\text{LOADING MACHINE RATE}} + \text{TIME OF CAR CHANGE}}$$

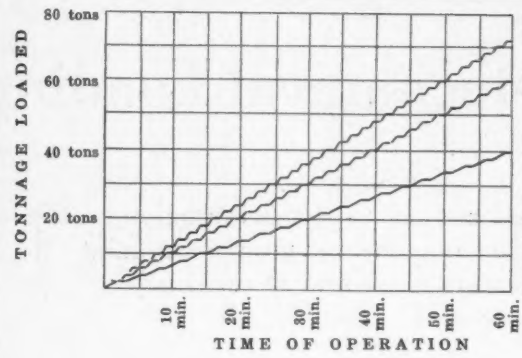

80 tons
60 tons
40 tons
20 tons
TONNAGE LOADED
10 min.
20 min.
30 min.
40 min.
50 min.
60 min.
TIME OF OPERATION
Production curve with a machine loading rate of 3 tons per minute.
Production curve with a machine loading rate of 2 tons per minute.
Production curve with a machine loading rate of 1 ton per minute.
Note.—Horizontal lines in curves indicate non-productive time of one minute for single car changes. Slanting lines indicate tonnage and loading time for one mine car of 2 tons capacity.

FIGURE 1

Curves showing a comparison of the production rates of a mechanical loading operation with varying machine loading rates. The capacity of the mine cars is constant at 2 tons and the time for a single car change is one minute.

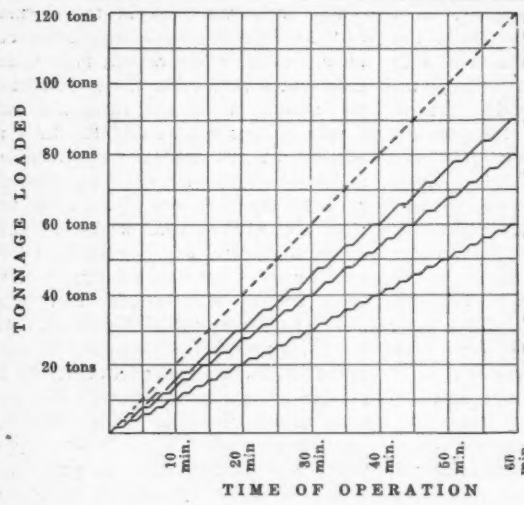

120 tons
100 tons
80 tons
60 tons
40 tons
20 tons
TONNAGE LOADED
10 min.
20 min.
30 min.
40 min.
50 min.
60 min.
TIME OF OPERATION
Dotted line shows production of machine operating at 100 percent capacity with no car delays. Rate=2 tons per minute or 120 tons per hour.
Production curve with mine cars of 6-ton capacity. Rate=90 tons per hour.
Production curve with mine cars of 4-ton capacity. Rate=80 tons per hour.
Production curve with mine cars of 2-ton capacity. Rate=60 tons per hour.
Note. — Horizontal lines in curves indicate non-productive time of one minute for single car changes. Slanting lines indicate tonnage and loading time for one mine car.

FIGURE 2

Curves showing a comparison of the production rates of a mechanical loading operation with mine cars of different capacities. The loading machine rate is constant at 2 tons per minute and a constant time of one minute is used for a car change.

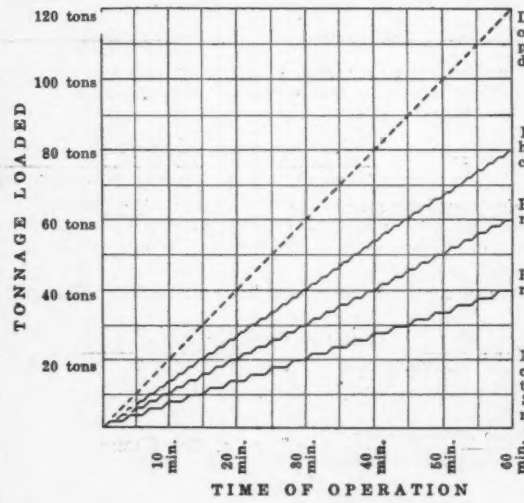

120 tons
100 tons
80 tons
60 tons
40 tons
20 tons
TONNAGE LOADED
10 min.
20 min.
30 min.
40 min.
50 min.
60 min.
TIME OF OPERATION
Dotted line shows production of machine operating at 100 percent capacity with no car delays. Rate=2 tons per minute or 120 tons per hour.
Production curve with one-half minute time for car change. Rate=80 tons per hour.
Production curve with one minute time for car change. Rate=60 tons per hour.
Production curve with two minutes time for car change. Rate=40 tons per hour.
Note. — Horizontal lines in curves indicate non-productive time for single car changes. Slanting lines indicate tonnage and loading time for one mine car of 2 tons capacity.

FIGURE 3

Curves showing a comparison of the production rates of a mechanical loading operation with varying times for single car changes. The loading machine rate is constant at 2 tons per minute and the mine car capacity is 2 tons.

plots the effect of increasing the loading machine capacity where the mine car capacity and the time of car change remains constant and shows that where the output of the operation is increased in this manner alone, there is a corresponding drop in the machine efficiency. It also shows that this efficiency loss is greater with a small capacity mine car than with a larger car. The curves in *Figure 5* show the effect of increasing the capacity of the mine car and reducing the time of mine car change with the machine loading rate remaining constant. This indicates that either of these changes have the effect of increasing the output and also raise the efficiency of the operation and bring it closer to the capacity of the loading machine.

Every mine operator who is using or contemplating the use of mechanized loading is interested in getting the greatest possible production from the equipment and the men employed, and the definite relation which exists between these three factors is immediately apparent on inspecting the graphs in the following figures. The value of knowing this relation lies in the fact that it gives an opportunity of determining which method of increase should be adopted at any particular mine and the cost of installing larger mine cars, the cost of bettering the haulage facilities so as to bring about a quicker mine car change or the cost of a larger loading unit can all be balanced against the production increase which will result. A production increase alone, however, may not be the correct answer unless the efficiency of the operation is also raised, as a larger output produced by a loss of operating efficiency may easily result in an increased mining cost.

FIGURE 1 shows the effect of increasing the loading machine capacity from 1 to 3 tons per minute with the mine car capacity remaining constant at 2 tons and the time of the car change at one minute. Under these conditions a loading machine rate of 1 ton per minute gives a theoretical productive capacity of 40 tons per hour; a machine rate of 2 tons per minute has a production of 60 tons per hour and a rate of 3 tons per minute produces 72 tons per hour. The productive rate is not in exact proportions to the machine loading rate as a 100 percent increase in the machine capacity from 1 to 2 tons per minute increases the production rate 50 percent or 20 tons per hour while a 50 percent increase in machine capacity from 2 to 3 tons per minute increases the production rate only 20 percent or 12 tons per hour.

FIGURE 2 shows the effect of changing the capacity of the mine car from 2 to 6 tons with the loading machine rate remaining constant at 2 tons per minute

and the time of car change at one minute. Under these conditions a 2-ton mine car gives a theoretical productive rate of 60 tons per hour; a 4-ton car gives a rate of 80 tons per hour and 6-ton car gives 90 tons per hour. The productive rate does not increase in proportion to the capacity of the mine car as a 100 percent increase in car capacity from 2 to 4 tons increases the productive rate 33 1/3 percent or 20 tons per hour while a 50 percent increase in car capacity from 4 to 6 tons increases the productive rate only 12½ percent or 10 tons per hour.

FIGURE 3 shows the effect of decreasing the time required for shifting single cars at the loading machine from two minutes to half a minute with the loading machine rate remaining constant at 2 tons per minute and the mine car capacity at 2 tons. Under these conditions where a car change requires two minutes the productive rate of the operation is 40 tons per hour; with a one minute car change the productive rate is 60 tons per hour and with a half minute change, the rate is 80 tons per hour. The productive rate is not proportional to the time of the car change as a 50 percent decrease from two to one minutes increases the productive rate 20 tons or 50 percent, while a 50 percent decrease from one minute to half a minute increases the rate 20 tons or 33 1/3 percent.

FIGURE 4 has curves showing the increase in the production rate of a mechanical loading operation which is made by increasing the loading capacity of the machine. Four curves are plotted with mine car capacities varying from 2 to 8 tons and all with a uniform time of one minute for a single car change. This figure also shows by a heavy dotted line the rate of production when the loading machine is operating at 100 percent capacity with no delays for car changes. By comparing each of these curves with the 100 percent efficiency line it will be seen that as the machine loading rate is increased, without either increasing the car capacity or decreasing the time for the car change, the line of production drops further away from the full machine capacity. The vertical distance between a curve and the dotted line at any point is the measure of the efficiency loss of the machine operating at the production rate indicated by the horizontal line passing through the curve at that point. This shows that to increase the loading rate of the machine alone has the effect of decreasing the efficiency of the operation. A comparison of the four curves with each other shows that an increased tonnage is obtained with a greater efficiency by using larger capacity cars and this same effect would follow a decrease in the time of the car change as will be illustrated in *Figure 5*.

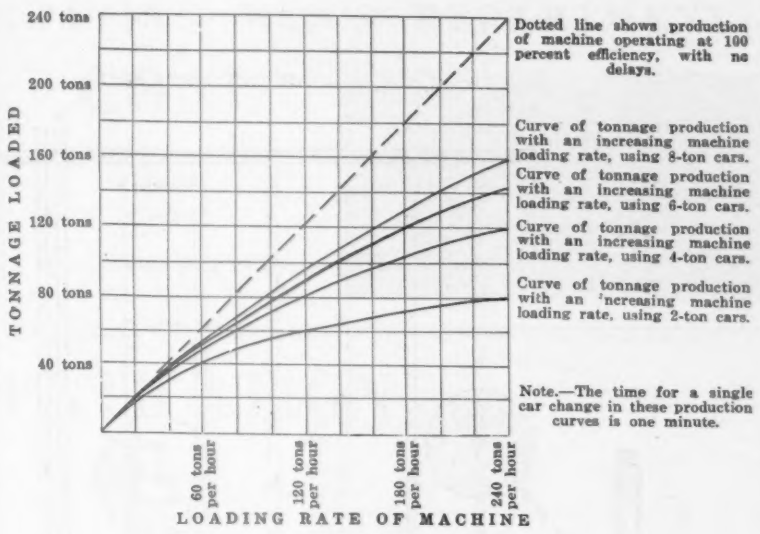

240 tons
200 tons
160 tons
120 tons
80 tons
40 tons
TONNAGE LOADED
Dotted line shows production of machine operating at 100 percent efficiency, with no delays.
Curve of tonnage production with an increasing machine loading rate, using 8-ton cars.
Curve of tonnage production with an increasing machine loading rate, using 6-ton cars.
Curve of tonnage production with an increasing machine loading rate, using 4-ton cars.
Curve of tonnage production with an increasing machine loading rate, using 2-ton cars.
Note.—The time for a single car change in these production curves is one minute.
60 tons per hour
120 tons per hour
180 tons per hour
240 tons per hour
LOADING RATE OF MACHINE

FIGURE 4

Curves showing rate of production increase made by increasing the loading rate of the mechanical loader.

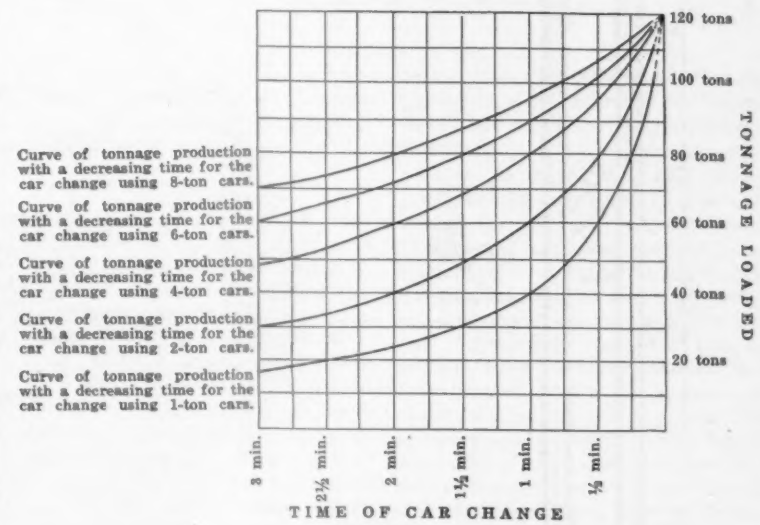
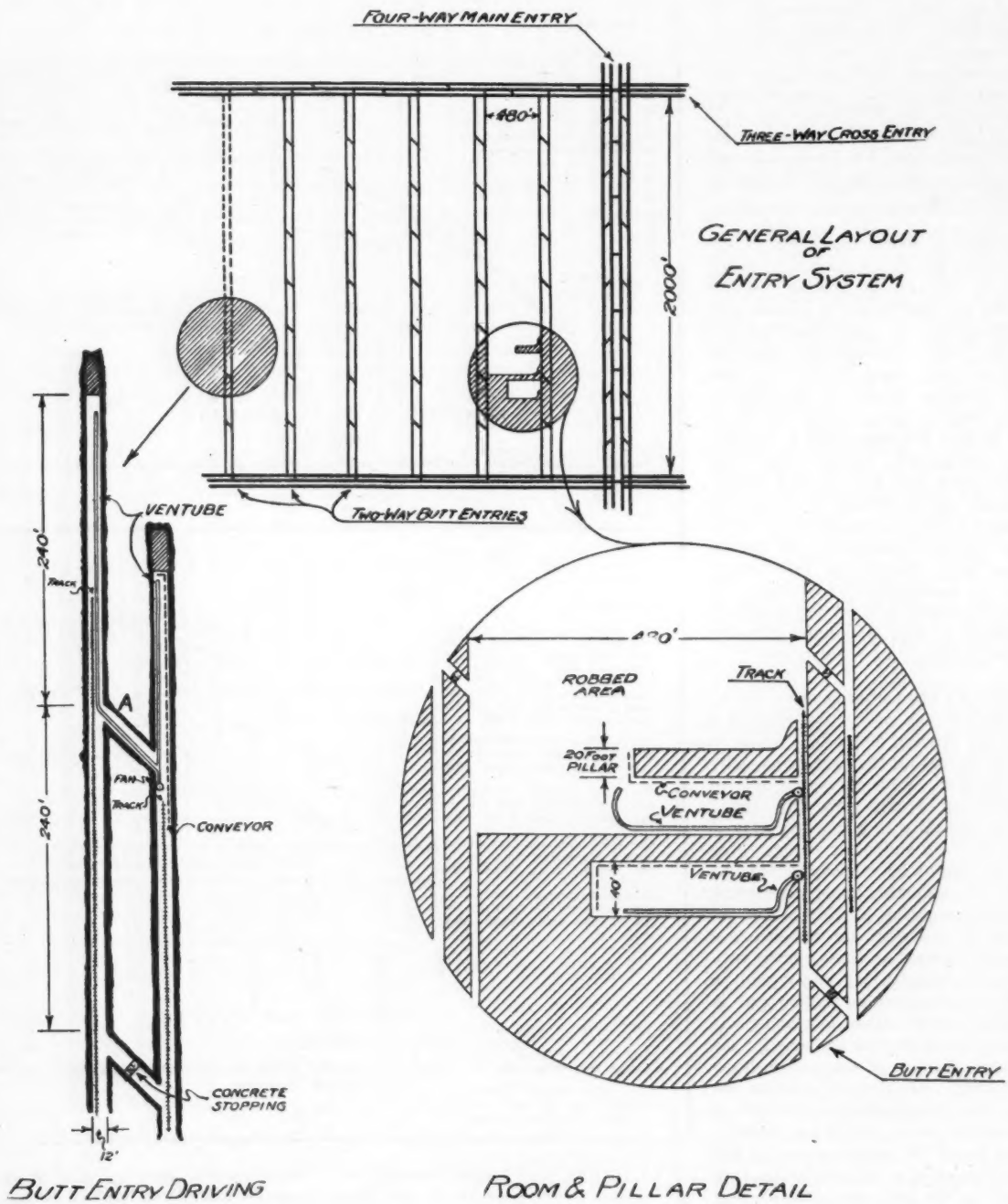

120 tons
100 tons
80 tons
60 tons
40 tons
20 tons
TONNAGE LOADED
Curve of tonnage production with a decreasing time for the car change using 8-ton cars.
Curve of tonnage production with a decreasing time for the car change using 6-ton cars.
Curve of tonnage production with a decreasing time for the car change using 4-ton cars.
Curve of tonnage production with a decreasing time for the car change using 2-ton cars.
Curve of tonnage production with a decreasing time for the car change using 1-ton cars.
3 min.
2½ min.
2 min.
1½ min.
1 min.
½ min.
TIME OF CAR CHANGE

FIGURE 5

Curves showing rate of production increase made by decreasing the time required for single car changes.

FIGURE 5 has curves showing increases in the production rates in a mechanical loading operation which are made by decreasing the time required for single car changes. Five curves are plotted with mine car capacities varying from 1 to 8 tons and all with a uniform machine loading rate of 2 tons per minute. The vertical lines indicate, at the points where they cut the curves, the increase in production rate which can be made by increasing the mine car capacities for any given time of car change. The horizontal lines represent the actual tonnage production and their intersections with the curves show several combinations between the car capacity and the time of car change required for that production when the machine is loading at a rate of 2 tons per minute. These curves show that an increased car capacity or a decreased time of car change gives a greater production and a higher operating efficiency as they all approach the line of full machine capacity of 120 tons per hour.



General layout of the entry system at the Stotesbury Mine of the C. C. B. Smokeless Coal Company

COAL

NEWELL G. ALFORD
Editor

Practical Operating Problems of the Coal Mining Industry

AUXILIARY VENTILATION on Butt Entry Work*

Application of blower and tubing for ventilation of working faces in entries, rooms and pillars in a conveyor operation—Faster rate of driving and decreased ventilation costs result

ONE of the Stotesbury mines of the C. C. B. Smokeless Coal Company is operating on a two-shift basis and getting out the well-known Pocahontas smokeless coal at the rate of about 300 tons per day. One auxiliary ventilating unit, consisting of a 5-hp. Jeffrey motor-driven fan and about 475 ft. of 12-in. Ventube is in regular use on butt entry work and two similar fans with shorter lengths of Ventube are used in connection with room and pillar mining.

General Mine Layout

The accompanying sketch shows the general layout of the entry system at Stotesbury mine. The four-way main entry leading off from the bottom of the slope will ultimately be several miles in length. Three-way cross entries lead off from either side of the main entry at right angles to it every 2,000 ft. The two-way butt entries are driven between the three-way cross entries and parallel to the main entry at intervals of approximately 480 ft. This leaves panels of coal measuring approximately 480 x 2,000 ft. for recovery by the room and pillar method.

The seam in the area now being worked is about 3 ft. 3 in. thick, making the conveyor system of loading the only practical one to use. Three conveyors and three gangs of men are regularly used, one driving butt entries and the other two working on the room and pillar system. The combined output of the three gangs, as previously mentioned, is approximately 300 tons of coal per day.

Room and Pillar Work

Methods: A sketch of room and pillar layout is shown on the same sheet as is the general layout of this company's entry system. Rooms are driven at intervals of 60 ft., center to center, off the butt entries. They are up to 240 ft. in length and 40 ft. in width, leaving pillars 20 ft. through. Two areas of this kind are mined simultaneously; one room being driven while the pillar is being recovered in the preceding room. A conveyor extends into each room and dumps into cars spotted in the entry. Each crew consists of five men, four working at the face and the fifth at the loading point in the room neck.

Two cuts are ordinarily cleaned up on each shift. Three shots are usually fired, one at a time. Ventube has been found effective, not only in supplying fresh air to the working crew during loading operations but also in clearing away the smoke and gas after shooting. Permissible explosives are used and the men can return to the face within one minute after each blast.

Ventube application: The fan supplying air to the Ventube system is located just back of the neck of the room which it serves, and the tubing is carried up to within about 10 ft. of the working face. No other method of ventilation has been used in connection with this kind of mining and it is the opinion of the management that no other system would be practical.

Cross-cuts might be used between rooms, but the feeling is that these would weaken the roof to a dangerous extent. This hazard would be greatest in connection with the pillar work, particularly at the time of removing the last stand of coal on the near side of a cross-cut. Furthermore, the use of cross-cuts between rooms would necessitate hanging curtains in the haulage-way just ahead of the last rooms driven. This closure would seriously interfere with the movement of trips and would need to be held aside every time a trip went through. The air current would thus be short circuited along the direct route up the entry, and it is considered that the uncertainties of this type of room ventilation far offset any good features it may have.

A typical butt entry is sketched, in process of driving, and the method is briefly described:

Driving methods: Butt entries, as previously explained, are driven in pairs, parallel to the main entry and with 480-ft. blocks of coal between. They are about 2,000 ft. long (between cross entries) 16 ft. wide and 6 ft. high when finished. Reference to the sketch, previously mentioned, will clarify the following description.

At the stage pictured in the sketch, the left-hand entry has recently been carried at a height of a little less than 4 ft.

* Survey by A. C. Nielsen Company, engineers, in cooperation with: C. R. Stahl, superintendent, and P. C. Graney, general manager, C. C. B. Smokeless Coal Company, Mount Hope, W. Va.

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to a point 240 ft. beyond the breakthrough shown at "A." The conveyor used for this work has been removed from the left and set up in the right-hand entry to carry out coal brought down as the latter entry is advanced. While part of the driving gang are at work on the right, loading coal on the conveyor, the others are getting out slate on the left and laying track behind them as rapidly as a 6-ft. car clearance is secured.

The conveyor gang will have progressed about 240 ft. and driven a breakthrough into the left-hand entry at that point at about the same time the track gang completes its removal of slate and lays track up to the left-hand face. The gangs will then change places, the conveyor crew beginning the removal of coal from another 240-ft. section on the left, while the other men continue their slate removal and track laying work in the next entry beyond breakthrough "A."

Ventilation: The position of the auxiliary fan and the Ventube duct during the driving operation just described is clearly shown in the sketch. The 12-in. duct is carried down both entries to within about 10 ft. of the working face on pegs driven into the rib. A single fan, with a 5-hp. driving motor, is equipped with a Y-piece and made to supply air to both lines of duct. Breakthrough "A," like those preceding it, receives a concrete stopping as soon as the next breakthrough has been opened 240 ft. further along.

Progress: The driving of a 6 x 16 x 2,000 ft. double-butt entry of this kind by methods just described requires a total of about 134 two-shift days—about 16¾ days for each of eight sections. There are seven breakthroughs and a corresponding number of concrete stoppings. Nineteen 25-ft. sctions of 12-in. Ventube, the maximum requirement, are kept on hand, and there are eight set-ups of the ventilating equipment.

Ventilation Costs on Double-Butt Entry Work

An accompanying table shows a brief summarization of the essential data regarding present methods and a detailed analysis of costs for a typical 2,000-ft. butt entry.

The Jeffrey fan used in connection with the Ventube system on entry work cost $324 originally and is depreciated on the basis of an expected five-year life. Depreciation, average interest at 6 percent, and a general allowance of $10 per year for repair and maintenance work gives a total fixed charge of $86.46. The fan is normally in use for about 300 days each year, and the cost for a 134-day period one-butt entry job is $38.62.

The 12-in. Ventube cost about $14 per 25-ft. length complete. Experience to date indicates an average cost of $237.62 per entry. This mine shows a total of not more than $10 per set-up for getting its Ventube up in an entry and putting the fan into position; this item figures $80 per entry and power for the fan motor costs approximately $201. The total cost for the seven concrete stoppings now required is $210. The five items listed above give a total of $767.24 as the present auxiliary ventilation cost per butt entry.

C. C. B. SMOKELESS COAL COMPANY STOTESBURY MINE

Ventilation Costs on Double-Butt Entry Work, Ventube and Fan

General data:	
Method of ventilation—du Pont Ventube.	
Entry dimensions—	
Length (single) .....feet..	2,000
Width .....feet..	16
Depth—	
Coal only .....feet..	3½
Coal and slate.....feet..	6
Distance between breakthroughs, feet..	240
Driving schedule—	
Between breakthroughs.....days..	16¾
Breakthroughs per 2,000 ft.....	7
Total days per 2,000 ft.....	134
Approximate length of air duct per set-up .....feet..	475
Number of set-ups per 2,000 ft. entry.	8
Ventube system:	
Annual charges on fan—	
Depreciation $324÷5-yr. life.....	$64 80
Average interest at 6 percent....	11.66
Maintenance and repair allowance.	10.00
Total annual fixed cost.....	$86.46
Costs per entry—	
Fan—$86.46 (300 days×134 days) entry	$38.62
Ventube—average	237.62
Labor—$10 per set-up×8.....	80.00
Power — 75 kw. hr. (day at $0.02×134 days)	201.00
Concrete stoppings—	
2½ cu. yd. at $12×7 required.	210.00
Total ventilation costs.....	$767.24

USE OF FROTH-FLOTATION PROCESS IN CLEANING COAL

The froth-flotation process, used extensively in the concentration of ores, has been applied within recent years to the separation of coal from ash-forming materials, says the Bureau of Mines in Bulletin 300, dealing with coal washing investigations, recently issued. Briefly, the process involves the agitation of raw coal, 1/10-inch size or finer, with 4 to 10 times its weight of water and a small quantity of reagent (0.5 to 5 pounds per ton of dry coal). The reagent with air forms a froth supporting the coal, which floats at the surface and may be removed, while the ash-forming materials are largely rejected and remain in the bulk of the water and may be separately removed. Many reagents may be used; these include certain oils, soluble organic substances, certain alcohols, and soaps. The process appears to be particularly applicable to coal that is originally fine or to those coals that are crushed to fine sizes as a part of normal preparation treatment, as for coking, or that require fine crushing to liberate the impurities. It seems especially suited to the treatment of sludge and slime produced at wet washeries when these products are high in ash. Other possible applications are to the recovery of free coal and interstratified coal which may be liberated by crushing middlings and washery refuse, and to the recovery of unburned fuel from boiler-furnace refuse.

BETTER OPERATION OF JIGS GIVES MARKED IMPROVEMENT IN CLEANING OF COAL

Studies designed to improve jigging practice in the preparation of Alabama coals have been undertaken by the United States Bureau of Mines and the University of Alabama, Tuscaloosa, Ala., in cooperation with the coal companies of that state. In that district, as elsewhere in the country, it is common practice to jig slack passing a screen varying in size from three inches to three-fourths of an inch. Under these conditions the fine sizes will, as a rule, be poorly cleaned unless careful attention is given to the strength of pulsion and suction strokes used. The pulsion stroke cleans the coarser sizes and the suction stroke the finer sizes. To get the best results with the pulsion stroke the amount of water and the length of stroke should be adjusted so that the bed just opens entirely to the bottom.

The most direct way for the operator to determine whether this condition obtains is to stick his arm down into the jig bed while the jig is in operation. If in doubt whether the bed is completely mobile on the pulsion stroke he should err in using a stroke too long rather than too short. A stroke considerably too long will do little harm, but one slightly too short will materially impair the efficiency of the jig. The strength of the suction stroke for best results depends upon the coal and the depth of jig bed. In most instances a suction stroke that pulls distinctly on the operator's arm will give good results on the fine sizes. This can be obtained on most jigs by reducing the quantity of water fed to the jig and at the same time lengthening the stroke to keep the bed fully mobile on the pulsion stroke.

In experimenting with suction the operator should not overlook the fact that suction has no effect if the bed does not open on the pulsion stroke. In general, no more suction should be used than necessary as it reduces the capacity of the jig somewhat. However, if in doubt, the operator should err on the side of too much rather than too little suction, especially if the fine sizes have a high ash content.

WASTE DISPOSAL SYSTEM of the Splash Dam Coal Corporation

By C. K. WEST *

Aerial tramway successfully handles difficult problem of waste disposal—Capacity for disposal doubled—Cost of system outlined—Increased efficiency through release of mine cars and main haulage locomotives

IT IS no particular secret that present conditions in the mining industry make close control of operating costs absolutely essential. In other words that, if profits are to be made, they must be made at the mine. It is also generally known that waste disposal is one of the most notable stumbling blocks in the way of economical operation. The physical aspects of the problem involved in the disposal of large quantities of waste material are usually bad enough, but the economic phase is usually worse. No doubt an analysis of operating costs in the average mine would show that a large percentage of the cost per ton was expended in getting rid of the waste. The situation has its bright side, however, in that because it does form such a large percentage of operating costs, waste disposal offers an excellent point of attack for any campaign directed at the reduction of such costs.

* Timken Roller Bearing Company.

As an example of what can actually be done along this line, the waste disposal system recently installed by the Splash Dam Coal Corporation at its Splash Dam, West Virginia, property is of considerable interest. Formerly the refuse was loaded in cars and hauled out to be dumped along the haulage track. This system was becoming increasingly unsatisfactory for several reasons, it damaged the haulage track, it tied up locomotives and cars, and it caused an unduly heavy labor expense. The problem of installing a better system was complicated by certain topographical features at the property. Briefly the situation was this: The mine is situated on a hillside overlooking the river, which at this point flows through a flood plain about 400 ft. wide and about 25 ft. below the level of the mine mouth. This plane offered an ideal place for a spoil pile, the land was worthless, there was enough room to last out the life of the property, and the periodic floods in the river would remove much of the waste material. The difficulty in utilizing the plan arose from the fact that the mine tipple, tracks, the main line of the C. C. & B. Railway, and a wagon road all run along a narrow bench between the river and the hillside on which the mine is located. The problem settled down to one of hitting upon the most economical and practical means of conveying the waste to the flood plain without interfering with traffic on the three routes that intervened.

After due consideration of various methods an aerial tramway was finally selected as best suiting the existing conditions. It was by far the cheapest method, both for operation, labor, and general maintenance, and it solved the difficulty of clearing the tracks and the road. A Williamsport single reversible aerial tramway has been installed which spans the tracks and road, and extends all the way to the opposite ridge. It is of some interest that the carrier used is of a type recently developed, in which the

General view of the tramway, showing beginning of waste disposal pile

View of the tramway from below, showing screen to prevent material from falling on railroad tracks

sheave wheels of the truck are mounted in Timken bearings. A sectional view of the mounting is shown in Figure 1. Several advantages have resulted from this type of carrier. Not only is there a saving in power consumption, but the expense for lubrication and maintenance of the carrier truck is practically negligible, and the life of the track line is lengthened because of elimination of wheel wobble.

The present method of waste disposal functions substantially as follows: The slats and refuse are hauled out with the coal trip, and dumped into a refuse bin large enough to hold several car loads. From the bin the refuse is loaded into the tramway bucket through a bin gate actuated by a lever that is accessible to the man who operates the tramway. Once loaded, the bucket carries the refuse out over the tracks and road, to a point over the flood plain, where it is dumped. The carrier is equipped with an automatic reversal dump, so that the operator can dump the load wherever he desires, the only operation necessary being to reverse the direction of the bucket travel. After being unloaded, the bucket is returned to the bin for reloading. Owing to the large capacity of the bin, operating the tramway is a part-time job for one man; the rest of his time is spent working in the tipple.

The contrast between the new and old methods is most striking, both economically and regarding effectiveness and convenience. With the old system the best that could be done in a day of 10 hours was to dispose of about 40 carloads of waste, aggregating about 100 tons. With the new system the capacity for disposing of material is doubled, and even on a basis of equal capacity the cost of handling is reduced two-thirds. To be specific, the cost per day under the old system was $14.50, which included a labor charge of $12.80 (time for four unloaders at $3.20 each) and a charge for power of about $1.80. The latter is based on the assumption that the haulage locomotive required at least 60 kw. hrs. for its two daily trips. With the new system, the labor cost is $3.20 for one man, whose whole time is charged to waste disposal, even though he actually spends only part of it on the tramway. As to power, the tramway is driven by a 20-hp. motor, but its average demand is only 10 hp. Since it is only in service about 80 percent of the time, a fair estimate of its power consumption would be 59.7 kw. hrs., or at $0.03 per kw. hr., its cost is $1.70 per day. The total cost of operating the tramway is, therefore, $4.90 per day, as against $14.60 for the old method, or a saving of $9.70. Reduced to cost per ton, on a basis of 100 tons per day, the corresponding results are $0.146—$0.049= $0.09 per ton per day. If the tramway is run to full capacity, the cost per ton would be $0.0245, and the saving $0.121, or 85 percent.

These figures take no account of some other factors that have considerable effect on the over-all operating cost of the mine. Formerly some 40 mine cars were held out of service every day, while the shale and refuse they carried was unloaded by hand. Also the main haulage locomotive lost two trips. At present all the cars are available at all times, and the haulage locomotive can make two more trips, which means that it hauls 60 tons of coal more in an eight-hour day. Reducing the whole thing to waste disposal cost in terms of tons of coal mined, the new system effects a saving of $0.02 per ton.

AMERICAN MANGANESE PRODUCERS' ASSOCIATION HOLDS SECOND ANNUAL CONVENTION

The second annual convention of the American Manganese Producers' Association was held in Washington, D. C., September 9 and 10.

Producers from the manganese states reviewed the progress made in their respective fields during the past year. Outstanding developments include the work of the Georgia Manganese & Iron Co., Georgia; the Hy-Grade Manganese Co., Virginia; the Domestic Manganese & Development Co., Montana; the General Manganese Corporation, South Dakota; the Chapin Exploration Co., Arizona; the Stange Construction Co., Virginia; the U. & S. Mining & Development Co., Montana; the Luna Manganese Co., New Mexico, and the New Mexico Copper and Mining Co., New Mexico. Dr. J. S. Grasty, consulting engineer, in reporting on deposits in Virginia, stated that of the total 300 deposits in that state only a few had been prospected and the problem of manganese mining was not one of lack of ore, but of selling the ore under the present market conditions.

Dr. Oswald Schreiner, U. S. Department of Agriculture, at the afternoon session of September 9, stated that manganese was essential to healthy normal plant development and that without it many plants showed symptoms analagous to disease condition, and further that manganese sulphate (a by-product of domestic mining) was used extensively as a fertilizer in southern Florida.

Senator Ashurst, of Arizona, presiding as toastmaster, at the informal dinner, Monday evening, stated that with adequate tariff protection on manganese he foresaw the development of a great and important industry within the country. William B. Daly, manager of Mines, Anaconda Copper Mining Company, as the speaker of the evening, definitely refuted the major claims of those favoring the removal of the tariff, by pointing out the presence of considerable tonnages of manganese within the United States, some 150,000,000 to 200,000,000 tons in a few developed deposits in Arizona, Virginia, Montana, South Dakota and Minnesota, alone without considering the 200 other deposits throughout the country, by citing the successful and commercially applicable processes of beneficiation, by indicating the rapid strides made in the manganese industry as compared with the early progress of the copper, zinc, oil and even the great steel industry itself, and by recalling the available estimated tonnages which can easily take care of the needs of the United States even in an emergency.

On September 10, the sessions were given over to the consideration of processes of beneficiation. Wilson Bradley, president of the Bradley-Fitch Company, and associated with the H. A. Brassert & Co., of Chicago, described his process of leaching carbonate ores with ammonium sulphate, which has been successfully demonstrated in his plant at Minneapolis. F. D. DeVaney, of the U. S. Bureau of Mines Experimental Station, Rolla, Mo., described and demonstrated the work carried on at the station during the past year on the flotation of carbonate and oxide ores. Adrian Nagelvoart, of the Delaware Chemical Engineering Co., successfully demonstrated his remarkable process of heavy liquid separation. New processes of beneficiation were reviewed by Prof. A. T. Sweet, of the Michigan College of Mines.

The association went on record as solidly backing the tariff provisions contained in Senator Oddie's amendment, namely, a tariff of 1½ cents per pound on the metallic manganese content of all ores over 25 percent manganese with protection for low grade ores; such a tariff being the minimum protection under which proper development of the industry can go forward.

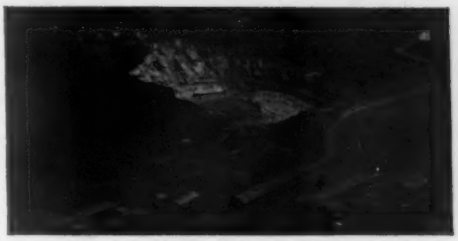
Officers of the association were re-elected, as follows: J. Carson Adkerson, president; John H. Cole, vice president; A. J. Seligman, treasurer; H. A. Pumpelly, secretary, and Richard H. Brown, chairman of the board. Directors elected for the coming year are as follows:

Richard H. Brown, president, Manhattan Electrical Supply Co., New York; A. J. Seligman, president, Butte Copper & Zinc Company, New York; John H. Cole, president, Domestic Manganese & Development Co., Butte; William B. Daly, manager mines, Anaconda Copper Mining Co., Butte; Francis P. Sinn, New Jersey Zinc (*Continued on page* 827)

METALS

GUY N. BJORGE
Editor

Practical Operating Problems of the Metal Mining Industry



VENTILATION of the Butte Mines, Anaconda Copper Mining Company

Latest ventilation practice outlined—Problem is temperature rather than purity—Mine timber heat an important factor—Exhaust ventilation adopted — Shaft compartments surfaced to reduce frictional resistance—Flexible tubing used in dead ends

By A. S. RICHARDSON*

VENTILATION of the Butte mines has been the subject of a number of publications by different authors, and most features of the subject have previously been quite fully discussed. This paper is therefore written to present the more recent practice at the mines of the Anaconda Copper Mining Company, but for the sake of completeness it is necessary to repeat much that has already been written.

As in the case of most metal mines where ventilation has become an important problem, the ventilation of the Butte mines is necessary mainly to reduce the high temperature and humidity of the air in the working places. Wherever a definite air circulation is established there is usually little depletion of the oxygen content and, in general, quality is a minor consideration.

Although there are a number of sources of heat contributing to the high air temperatures, the predominating cause is the naturally high temperature of the granite country rock. Furthermore, this is of constantly increasing relative importance due to great increase of temperature with increases in depth to which the mines are being developed.

Temperature of the ground is not constant throughout the district as a whole, but is lowest in the northern areas and highest in the central areas, near the Anaconda vein system. At the Badger State mine, in the northern part of the district, the temperature of freshly opened ground on the 3,400 level approximates 98 degrees F., while the temperature at the same level of the Belmont mine, on veins belonging to the Anaconda system, was 115 degrees F. The increase in temperature with increase in depth at the lower levels, as noted at the Original mine, was 14 degrees F. in 400 ft., or from 104 degrees F. on the 3,400 level to 118 degrees F. on the 3,800 level.

Heat due to mine timber is of considerable importance, but the rate of decay and heating effect vary greatly under different mine conditions. Where the air is cool and dry there is comparatively little temperature increase, but after the mine atmosphere becomes heated and humid the decay is more rapid and much greater temperature increases may be expected. Large quantities of timber are used, and the effect upon both temperature and quality of mine air is probably greater than that due to any cause other than the natural heat of the ground.

One very important cause of temperature increase that can be definitely figured is the rise in temperature due to compression of air in the downcast shafts due to the increased weight of the atmospheric air column. At an elevation of 6,000 ft. above sea level, which may be assumed for many Butte shafts, the normal barometric pressure approximates 26 in. of mercury, while at a depth of 3,000 ft. below the collar it is increased by nearly 3 in. of mercury. The increase in temperature under adiabatic compression between these pressures is 18 degrees F.

Surface temperatures in Butte are low and the mean annual averages approximately 40 degrees F. Assuming therefore that no heat were to be picked up from the ground, or any other way, we might expect a mean average temperature of 58 degrees F. at the 3,000-ft. level. As a matter of fact, the shaft temperatures are generally at least 10 degrees higher at this depth. In a few shafts the temperatures are not much higher than might be figured from the heat of compression, but there is always an increase in the moisture content of the air, and when the latent heat of evaporation of the water vapor is taken into account an increase in heat during flow through the shaft is always indicated.

Electrical power consumption is constantly increasing. Motors required for underground fans and blowers approximate 4,300 hp., and the total underground power consumption is somewhat higher than 16,000 kw. heat loses, based on the efficiency of different pieces of equipment, may be figured to be in excess of 150,000 B. t. u's per minute. Temperature rise of the air that is affected varies considerably. One pump station causes an increase of 12 degrees F. in a flow of 65,000 cu. ft. per minute, and the average temperature of the work-

* Ventilation Engineer, Anaconda Copper Mining Company, Butte, Mont.

ing zone is probably raised about 4 degrees F. by heat given off by electrical equipment.

The general plan of ventilation is an exhaust system that is made operative by fans at the collar of the air shafts, which draw air from the mines and thus make the workings shafts the main downcast inlet air courses. This plan was adopted for several reasons, most important of which is the fact that the working shaft is clear of smoke in case of any fire occurring within the mine, and thus remains a safe escapeway for the men and a base for fire-fighting operations. Working conditions in the operating shafts and on the stations are, of course, much better than they would be if the shaft were an outlet air course, and there is less corrosion of cages and other shaft equipment.

With two exceptions, all of the surface fans are of the reversible type, so that the direction of flow in the air shafts may be controlled as desired. Although the conditions arising at the time of a mine fire may not make it necessary to reverse the direction of flow, there can be no question as to the value of facilities for quickly doing so in case such a necessity should arise. This has been proven as a matter of actual experience in several instances in the Butte district.

All main surface fans are set at a short distance from the shafts and connected to them by inclined air ducts so that the collars are unobstructed, and the shafts are accessible for repairs or any emergency use. Construction of fans, housing, and air ducts is fireproof, and concrete is used as far as practicable in order to minimize corrosion by condensed water vapor, as this is very severe. One feature that has been adopted in a number of installations is the use of butterfly dampers in the inlet air courses for the purpose of quickly regulating the fan suction effective on the mine to any required degree in case of fire.

Power is supplied by electrical motors and transmitted to the fans by belts. In some cases, the enlargement and remodeling of main air courses has considerably reduced the resistance to the flow of air, and the resulting increase in volume of flow necessitated changes in the fan speed that were readily accomplished by changing pulleys.

The volume of air circulated through the mines is restricted within rather close limits by the air-carrying capacity of the shafts. At an operating depth of 3,000 ft. the vertical travel in the shafts, downward and upwards, approximates 6,000 ft., while the courses through crosscuts, drifts, and stopes do not ordinarily exceed 20 to 40 percent of that length. Frictional resistance to flow varies as the square of the velocity of air movement, and since all of the air must flow through the shafts, the velocity there is much greater than it is in the working zone, where it is split into a number of parts as required for the ventilation of different sections of the mine. The pressure required to force the air through these main workings is, therefore, small by comparison with that required to overcome the frictional resistance in the shafts.

All of the older air shafts of the district were formerly used for operating purposes and timbered with the common type of rectangular framing. The resistance to air flow that is offered by such a framing is considerably higher than that of a shaft in which each compartment is surfaced so as to make it into a separate air duct. Since shaft resistance is such an important factor in restricting the air flow, the air shafts have, therefore, been surfaced so as to make each shaft compartment into such a separate air duct. Most recent practice along these lines has been to line inside the shaft timbers with 1-in. boards sufficiently long, when placed in vertical position, to extend over three sets of shaft timber. These boards are fastened in place by wooden pegs. Under conditions created by exceptionally heavy ground, the shaft timber has been reinforced and a fairly smooth surface obtained by cribbing between the members of the existing frame and thus forming a solid skin-to-skin timber support.

On account of the high temperature of the water and freshly opened ground on the lower levels, the air used in ventilating them becomes greatly heated and humidified. It then has a detrimental effect upon the ventilation of any other working places through which it may subsequently be passed, and it is desirable to divert it to main outlet air courses as directly as possible. To accomplish this it is necessary to carry the outlet air shafts to the same depth as that of the lowest level of the operating shafts, and this is an important objective in the ventilation plans.

In carrying such extensions of the existing air shafts to greater depth, a change in design has been made consistent with the purpose for which they are to be used. The ideal air course has, of course, a circular cross section and smooth surface to reduce frictional resistance. A close approximation to this design is obtained with an octagonal-shaped shaft supported by skin-to-skin, treated, timber. Taking into consideration the first cost and opportunity for repairs, this has seemed the most suitable for the Butte district and is the type adopted.

In locating these extensions to the old vertical air shafts, a primary consideration has been to have them so situated that they will give best service to the area to be ventilated. In a number of cases the new extensions are not vertical but are carried on a line roughly parallel to the dip of the veins and at a short distance from them, so as to reduce the length of air courses connecting to them. Also, in some places these extensions have not been carried from the bottoms of the old shafts, but at some distance from them, and connections between the two have been made by large-sized crosscuts.

In one case, where an old four-compartment air shaft needed retimbering the original type of rectangular framing was abandoned and, with some slight increase in width, it was possible to remodel the shaft so that it had only two compartments symmetrical about a central spreader and with end framing containing three elements of an octagon. The new timber was placed skin-to-skin so as to furnish a fairly smooth surface. Increase in area and reduction of frictional resistance thus obtained were had at comparatively low cost and substantially increased the volume of flow.

As increase in depth necessitates a greater volume of flow through the inlet air courses, or main operating shafts, this will be made available by the removal of ground for additional compartments that can be used only for carrying air, and that may be lined with boards in the same way as the outlet air shafts. One such compartment was added to the Mountain Con shaft when it was recently retimbered, and after surfacing will approximately double the volume formerly carried by the shaft.

Balance between the carrying capacities of inlet and outlet shafts is not always obtainable with best arrangements for the ventilation of the workings and with the necessity for maintaining the operating shafts as inlet air courses. However, with the consolidation of operations through a fewer number of shafts it has been possible to reverse the direction of flow through some of the shafts formerly used for operating purposes, and also to make downcast shafts out of some of the air shafts, with considerable improvement in results.

Air distribution can hardly be covered in detail on account of the number of mines involved. It is not possible to work out systematic plans in advance of operations because of irregularity in shape and size of ore deposits and uncertainty as to their continuity. All general plans may, therefore, require revision from time to time in order to meet developments as they arise.

Under an exhaust system of ventilation the main difficulty to efficient distribution is the tendency of the air to short circuit from inlet to outlet courses and thus leave the most important bottom levels without sufficient flow. Doors and other stoppings are, of course, used to prevent this, but leakage losses always occur, and the flow of air to remote sections of the mine is further reduced by the greater resistance of the longer air courses. To prevent such leakage losses by a redistribution of ventilating pressure, and also to overcome the higher mine resistance of the longer air courses a large number of booster fans are used underground to supplement the ventilating pressure of the main surface fans and to divert the air flow to these sections of the mine where it is most needed.

The equipment in this service has in the past been derived from a supply of old surface fans of nonreversible type that were replaced some years ago by reversible fans of larger size. All of these fans are of the centrifugal type

with multivane wheels, or impellers, having forward tipped blades, and belt driven by electric motors. The newer equipment has included both centrifugal and disc fans, but the centrifugal fans have wheels with backward tipped blades. These fans are particularly well adapted to underground booster service because they run with nearly uniform power consumption under any variation in mine resistance. There is, therefore, no trouble with them in case doors are left open and a short circuit created in the ventilation system, a condition that causes much trouble on account of overloaded electrical equipment and belt drives with the older equipment. Another point is that for a given pressure a higher peripheral speed of impeller is required and the number of revolutions per minute may more readily be adapted for driving direct connected to alternating current induction motors. Disc fans have, of course, only a limited applicability on account of the lower pressure developed by these offered by the manufacturers.

For the ventilation of dead ends where it is most important to reduce temperatures at the working face, it is the general practice to blow fresh air to the face through flexible tubing. This method of ventilation is particularly well adapted to accomplish such a result because the air is thus moved at high velocity through the tubing and is therefore less subject to temperature increase and humidification than it would be if moved at lower velocity through the larger area of the crosscut or drift. Some further advantage is also gained by the discharge of air at high velocity from the end of the tubing as it causes an induced general movement of the air in this vicinity, and thus increases its cooling power.

Sizes of flexible tubing used for different types of service are: 8-in. diameter for raises and short runs up to 200 ft.; 12-in. diameter for crosscuts and drifts where the run is not over 500 ft.; and 16-in. diameter for runs up to 1,500 ft. Tubing as large as 24 and 36-in. diameter is also used in certain cases where an extra large volume of air is required, as in the case where splits are taken for the ventilation of a number of places, or for part of the distance of long runs of over 1,500 ft. Development work on three levels off the bottom of a working shaft was ventilated by splits of smaller tubing from a 36-in. diameter line carried down one shaft compartment.

Blowers used in this connection are of the centrifugal multivane type, having the wheel, or impeller, carried directly on the shaft of an alternating current induction motor so that operation is restricted to constant motor speed. The older type of equipment had impellers with forward-tipped steel blades and cast-iron housing. Pressure developed by this type is rather closely limited, and when the resistance to the air flow is increased by the addition of increasing length of tubing there is a marked reduction in the volume of air delivered. Power consumption also decreases with increase in the length of tubing, and becomes maximum with free delivery such as will occur in case the tubing is accidentally disconnected from blower. In this case it is approximately twice that required to drive the blower under normal conditions, and in order to avoid trouble with the electrical equipment it is necessary to provide a motor of sufficient power to meet all such conditions.

To remedy the undesirable characteristics of such equipment a new blower was developed some years ago in cooperation with the fan manufacturing company. This newer equipment is of the centrifugal type, but the impellers have backward-tipped blades and the pressure that is developed increases considerably as the increased length of tubing tends to restrict the air delivery. Power consumption is nearly constant under all conditions of operation, so that it is not necessary to provide excess motor capacity. Also, on account of the fact that a higher peripheral speed of the impeller is required for the backward-tipped blades to develop a given pressure, it is possible to use higher speed motors and substantially reduce the size of the equipment, thus making it much more easily handled in the mine. With the older equipment it was found that a fire hazard existed in case of faulty alignment, or adjustment, as sparks might then be thrown off by the steel impeller striking against the housing. In the newer equipment a cast of aluminum alloy has been employed throughout, and this not only eliminates the hazard but greatly reduces the weight.

A comparison of the new and old blowers used as standard equipment for 16-in. diameter flexible tubing, which are designated "A" and "B," respectively, is as follows:

	Fan "A"	Fan "B"
Delivery	3,000 cu. ft. per minute at 4.25-in. pressure	3,000 cu. ft. per minute at 6.5-in pressure.
Motor	10 hp. at 1,140 r. p. m.	5 hp. at 3,460 r. p. m.
Weight of motor and blower	1,150 pounds	310 pounds
Outside dimensions	47 in. x 39 in. x 44 in. Requires sectionalizing for movement on cages.	37 in. x 28 in. x 28 in. Can be placed on any cage without sectionalizing.

Equipment for booster service underground circulates approximately 2,000,000 cu. ft. per minute. The number of fans required for this service is constantly increasing; at the time of writing 38 were in use, and these required motors of 2,800 total horsepower.

Ventilation of dead ends requires about 450 blowers, driven by motors of 1,500 total horsepower, and maintenance of the lines of ventilation tubing requires an annual installation of 150,000 to 200,000 lin. ft. of flexible tubing.

Total power consumption is close to 9,000 hp., all of which is in practically continuous operation.

For future ventilation requirements, consideration has been given both to the possibilities of further improvement of present measures and of artifically cooling the mine air, as has been proposed and, to some extent, practiced in other places. Technically, there are no unsurmountable obstacles to be overcome in applying such a method to the Butte mines, but its use depends more upon economic factors. These, of course, vary at different properties. In tropical or semitropical climates the surface atmosphere is likely to be of relatively little value in improving ventilation conditions within the mine, because of the initial high temperature and humidity of the air entering the mine. In the Butte district, surface temperatures and humidity are decidedly low and offer much greater opportunity for reducing the mine temperatures. Cost of artificial cooling will, of course, depend to some extent upon the process used, and will also vary widely with conditions at different properties. Its general application to extensive workings in the case of any problem of deep mines can hardly be other than a matter of very considerable expense. Under exceptionally severe conditions, such as may occur in dead ends during the development of lower levels, the use of artificial cooling may be warranted. For the main ventilation system in the Butte mines it seems, however, that reliance upon present methods will economically be most advisable, at least for some time to come.

As a matter of statistics, the requirements for the ventilation of the mines may be briefly summarized as follows:

The total volume of air circulated by the surface fans is, approximately, 3,000,000 cu. ft. per minute.

Assuming an underground force of 5,000 men, this is equal to 600 cu. ft. per man per minute.

Taking the weight of air at .06 pound per cubic foot, the total weight of air circulated through the mines per day is 129,600 tons, or about 15 tons of air per ton of ore.

There are 29 air shafts that are equipped with fans, and these require motors of 4,500 hp., which are, of course, in continuous operation.

Anaconda's ZINC OPERATIONS and the Development of COMPLEX ORES

Zinc for many years a menace in ores—Electrolytic zinc process the solution—Power the largest single cost item—Real progress began in 1915—Idaho, Utah and Montana now contribute one-third of national zinc production

By RUSSEL B. CAPLES*

MANY articles describing electrolytic zinc processes and plants have appeared in the technical press during the last 10 years, and a description of the present plants at Anaconda and at Great Falls, Mont., appeared in a recent issue of the *Engineering and Mining Journal*, so in order to avoid repetition, no description of the operations of the Anaconda Company's plants will be attempted in this paper. It will be necessary, however, to briefly review the history of electrolytic zinc and of the complex zinc-lead ore problem.

The first record of experiments of roasting and leaching of ores followed by electrolysis of resulting solution of metals dates back to 1854, and as early as 1880 there appeared patents covering processes for commercial recovery of zinc by electrolytic methods. Since that time numerous patents have been issued and several electrolytic zinc processes were tried out on a semicommercial scale, but none of them (with one possible exception) reached what could be called successful operation, prior to 1915. It may be said that in 1915 the electrolytic zinc process represented nearly 40 years record of failure in attempts to place it on a commercial basis. With such a record, raising a large amount of capital for building a plant appeared to be a decidedly risky move.

For many years prior to 1915 it had been known that large bodies of ore containing zinc, lead, copper, silver, and gold existed in some of the Western States and in Canada, and large sums of money had been spent in various efforts to work out processes whereby these ores could be treated at a profit. Distance from markets for zinc product, undesirability of class of zinc product as compared with Joplin and other high-grade concentrates, and poor separation of lead and zinc by gravity concentration methods were factors working against successful exploitation of these ores.

In addition to the strictly complex ores, most of the lead ores produced in the Western States carried some zinc, and the amount of zinc was increasing with depth of mining operations. In most instances, no attempt was made to save the zinc on account of the small net return, after paying freight and treatment charges, being insufficient to justify the added expense for its recovery. Zinc constituted a real menace to lead mining operations on account of increasing smelter penalties for zinc in lead concentrate, and an increase in zinc content of ore was viewed with alarm by producers of lead.

The Anaconda Copper Mining Company owned mines in the Butte district which contained large tonnages of complex zinc-lead ore carrying high values in silver and gold. In 1914 they seriously undertook the problem of working out a method of treatment for these ores and soon decided that electrolytic zinc offered the greatest promise. The first laboratory work was done on crude ore carrying about 18 percent zinc, but it was soon decided to use flotation and produce a concentrate carrying from 30 to 35 percent zinc. War demand for high-grade zinc became urgent, and within 18 months after starting laboratory work construction of a plant at Great Falls, Mont., to produce 100 tons of zinc per day was started, and the plant was put into operation late in 1916.

Plant construction had gone ahead so rapidly that mine development had not kept pace, so it was soon necessary to purchase some outside concentrate in order to supply plant requirements. War prices for metals and the advent of the flotation method of concentration had stimulated production of zinc in Idaho, Utah, and Montana, making several small tonnages available. These were purchased and treated at Great Falls, thereby putting the Anaconda Company into the custom zinc business at the start of its zinc operations.

Owing to the short time for experimental work, the process as installed at Great Falls was far from perfect, but it served to supply the much-needed high-grade zinc for munition purposes. Also, it was designed to treat only low-grade concentrate. Development of the process was pushed as rapidly as possible without interfering too much with zinc production, and in 1918 some large tonnages of high-grade concentrate were purchased in the Butte district and the problem of treating this class of material was successfully solved, resulting in gradually taking over the entire production from the Butte district and enlarging the Great Falls plant.

When the 1921 slump in metal prices came, freight rates and production costs were so high that only a few mines could continue to operate at a profit, and the Great Falls plant was closed down from lack of feed. The flotation process had made rapid strides and was being generally adopted, either as an adjunct to gravity concentration or entirely replacing it, and selective, or preferential, flotation was being tried out on complex ores with encouraging results. The problem of disposal of the zinc product remained, as increases in freight rates and in production and treatments costs had largely offset the benefits derived from improved concentration methods. It had been demonstrated, however, that the concentration problem was practically solved and that large potential tonnages of zinc concentrate were available in the Northwestern States, if they could be marketed at a profit.

In 1923, the Anaconda Company was offered some small tonnages of zinc concentrate from the Coeur d'Alene and Salt Lake City districts, which were being produced as a by-product from lead concentrate production. Attempts had been made to market these tonnages to retort plants, but the net return was insufficient to encourage continuance or expansion of production. Terms were offered for these tonnages and shipments started to Great Falls. Additional equipment was installed in these mills to enable them to recover more zinc, which was then going out with the mill tailing. The success of these companies in producing and marketing zinc concentrate encouraged other companies to go ahead along the same line, resulting in a marked increase in zinc production from these districts in 1924 and 1925. Expansion of production of zinc and opening up of new production from complex ores in these districts has continued until the present production of zinc from Idaho, Utah, and Montana is nearly one-third of the total from the United States.

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It has been necessary for the Anaconda Company to enlarge its zinc production capacity from the original 100-ton-per-day unit at Great Falls to a 350-ton-per-day unit at Great Falls and a 175-ton-per-day unit at Anaconda, giving a total capacity of approximately 1,000,000 pounds of zinc per day. The building of these large units near the source of the required amount of power and combining them with the other large operations of the Anaconda Company have resulted in a better situation for the producers of zinc concentrate than if independent units near the sources of concentrate had been attempted. The larger the unit, the lower the capital outlay per ton of zinc producing capacity, on which interest and amortization charges must be assessed against concentrate treated, and the lower the operating cost. Combining zinc production with other operations effects a material reduction in overhead charges. Power is the largest single item of cost in production of zinc by the electrolytic process, therefore the rate for power is a very important item. When operating at capacity, the zinc operations of the Anaconda Company require over 80,000 horsepower. The combination of these factors existing at the Montana locations has more than offset the freight charge on concentrate to these plants.

It is doubtful that a very high percentage of the zinc concentrate being shipped to the Anaconda Company plants could be positively guaranteed for more than a year or two in the future, as few of the mines carry developed ore reserves far ahead of current requirements. To insure continuous operation of installed plant capacity, the Anaconda Company has developed and equipped its own zinc mines beyond present needs and holds them in readiness to act as a balance wheel on concentrate supply. The intermittent operation of these mines is not productive of the maximum return from the ore extracted, but is made necessary by fluctuations in custom concentrate supply.

Until very recently, the zinc plants of the Anaconda Company represented the only commercial installation of the electrolytic zinc process in the United States, and they have offered the most favorable market for zinc concentrate produced in Idaho, Utah, and Montana since 1922, with the possible exception of a temporary situation in 1925. Without these plants, practically no zinc would have been produced in Montana since 1921, and the development of zinc production in Idaho and Utah would not have gone ahead as rapidly as it has during the last six years.

The Anaconda Company early recognized the fact that production of metals is a partnership arrangement between mine and reduction plant, and that in order to develop a mine there must be the incentive of profit, therefore it is not good business for the reduction plant to exact from the mine all that "the traffic will bear." Accordingly, purchase terms for zinc concentrate have been figured to return to the treatment plant only such profit as sound business principles demand, giving as much as possible to the mine. Benefits derived from improvements in the process, enlargement of plant, reductions in freight rates, etc., have been reflected in reduced treatment rates, as soon as definitely established, and in some cases such improvements in conditions have been discounted in advance in order to aid producers in getting started. The greater the payment to the mine for its products, the greater the amount available for development of more ore and the greater the tonnage of ore that is made available for extraction at a profit. The result of this policy has been to recover for useful purposes many tons of zinc which would otherwise have "gone down the creek" in mill tailings from lead mining operations, or would have remained in the ground as being of too low grade for profitable extraction.

The success of the Consolidated Mining & Smelting Co., at Trail, B. C., and of the Anaconda Copper Mining Co., at its Montana plants, in developing and applying the electrolytic zinc process on a very large scale to a wide variety of zinc-bearing materials has given the producers of complex zinc-lead ores definite assurance of an improving market for their zinc product, so that they have been able to interest capital in the development of such mines and building of mills, and it has also attracted capital to the building of other electrolytic zinc plants, so that there is now installed capacity for production of over 1,200 tons of electrolytic zinc per day, scattered over the world, with several additional installations planned. From no production of zinc by this process in the United States 15 years ago, nearly 30 percent of present production is electrolytic zinc, practically all of which comes from the so-called complex ores of Idaho, Utah, and Montana.

The following tabulation, taken from Economic Paper 2, of the U. S. Bureau of Mines, "Summarized Data of Zinc Production," is indicative of the growth of zinc production in the Northwestern States since advent of flotation and electrolytic zinc.

MINE PRODUCTION OF RECOVERABLE ZINC (SHORT TONS)

	1921-1925 Annual avg.	1926	1927
Idaho	7,867	26,307	25,300
Utah	8,769	47,590	47,900
Montana	52,760	73,701	71,700

As indicating the growth of zinc production in the Coeur d'Alene district since 1922, the following tabulation gives the tonnages and zinc content of zinc concentrate purchased by the Anaconda Company in this district.

TONNAGES AND ZINC CONTENT OF ZINC CONCENTRATE PURCHASED BY THE ANACONDA COPPER MINING COMPANY IN THE COEUR D'ALENE DISTRICT

	1923	1924	1925	1926	1927	1928	1st 6 mos. 1929
Tons of concentrate	6,046	22,470	29,388	37,735	41,790	56,490	34,330
Percent zinc	40.4	40.8	42.3	47.0	49.5	50.6	49.3

From this tabulation it will be noted that 1929 production of zinc will be approximately twice that of 1926. During the period covered by this tabulation the Anaconda Company has paid to the producers of the Coeur d'Alene district approximately $7,000,000 for the concentrate purchased, with indications that purchases for 1929 will be well in excess of $2,000,000.

Similar complete data for the Salt Lake City district are not available, owing to the necessity of diverting part of the production from this district to retort plants during periods when production was increasing more rapidly than treatment plant capacity could be increased. In 1924 purchases amounted to 18,000 tons of concentrate, averaging 49 percent zinc; 1925 purchases amounted to more than 60,000 tons, averaging 51 percent zinc; and indications are that 1929 purchases will be more than 120,000 tons, averaging over 53 percent zinc. Up to July 1, 1929, purchases of zinc concentrate in the Salt Lake City district by the Anaconda Company had totaled approximately $16,000,000 and are being made at current rate of $4,500,000 annually.

In addition to purchases from Idaho, Utah, and Montana, the Anaconda Company plants have treated smaller tonnages from Colorado, Washington, and British Columbia.

With the continued development and application of the flotation process to the complex zinc-lead ores, and with the assurance of a market for both the lead and zinc products, it seems safe to predict a steady growth in production of both lead and zinc from this region, although at a somewhat slower rate of growth than has maintained during the last six or seven years. As this growth continues the market for the products will improve, through greater size of treatment units and improvements in processes employed, making available for profitable extraction lower grade ores with correspondingly greater tonnages. The Anaconda Company has derived a great deal of satisfaction from the part it has played in bringing about this development and hopes to continue to serve and to better serve the mining industry of the Northwestern States.

MINE DEPLETION ALLOWANCES
(*from page 804*)

1926, the report states the percentage of tax paid by them was 18, while mining and quarrying paid 12 percent. It is stated that taxable net income of metal mines is reduced on an average of 44.5 percent by depletion and coal mines by 16.4 percent. Mr. Parker states that the reasons on which the discovery provision was enacted are now inapplicable as the tax rates have been materially reduced since 1918. The greater part of the benefit from the discovery depletion is declared to have been received by corporations and not by individual prospectors for whom it was primarily intended.

The report states that the 15 percent flat rate for depletion applied to gross income recommended by the American Mining Congress during consideration of the last tax bill "does not seem to meet the requirements as to uniformity of tax burden." It is said the method would be only effective with increasing the tax in the case of future discoveries and would reduce the Government revenue. The method would also lack simplicity as it would retain the 1913 value and eliminate the discovery value only with respect to the future. The plan would also allow the metal mining industry a greater advantage than under the present law as the proposal would place no limit on the total depletion allowances, except that brought about by exhaustion of the mine.

Rates Proposed

To test the practicability of percentage depletion, the report uses a rate of 33 1/3 percent on net income of the property, and 40 percent depletion on net income after allocating a reasonable amount of net income to the plant investment with an adjustment of net income of 6 percent on the plant investment representing the profit allocated to such investment, which it is said would cause less variation in results than under the present system. It is stated that computations have been made which show that the proposed plans are adaptable to lead, zinc, iron, copper, gold and silver mines alike. It is estimated that the coal industry, which Mr. Parker says "seems to have been discriminated against in the matter of depletion," would result in a reduction of 21 percent in taxes under the first plan and 15 percent under the second plan. "While the change in depletion seems large, the percentage reduction in tax may be reasonable," says the report. "The 15 percent reduction under the second plan is warranted in view of the depressed condition of the coal industry and the small relief allowed it under the present system."

It is stated that neither plan appears applicable to non-metals taken from surface excavations as the value of such business is chiefly from its plant investment and efficiency of management rather than the value of the product mined.

Further statement is made that "the copper industry receives too much depletion, while the coal industry receives inadequate allowances." It is said that the second plan would allow a greater reduction to coal and a less deduction to copper than under the present system and that the increase in tax in the metals industry will probably fall principally on the copper group. "The copper industry paid cash dividends of $18,000,000 in 1924, while the lead and zinc industry paid only $3,000,000," the report continues. "Under the present method the tax on copper companies is 8 percent of the dividends and 30 percent on those of the zinc companies. Under the second plan the percentages would be 15 for copper and 33 for lead and zinc. It would not appear that the increased tax on copper by the second plan would result in hardships because the present price of copper is in excess of that in 1924, the depletion allowances would be greater and the increase in tax less than shown by the computations in this report."

Advantages Summarized

Summarizing the advantages of depletion based on net income the report says:

Percentage depletion has a relation to the value of the ore as does the present method, whereas the fixed rate method and gross income method have no relation except to value.

The change in method will be less disturbing in effect than in other methods.

This method is simple in its application and eliminates the many factors of speculation and uncertainties entering into present methods of valuation.

It requires but one computation for depletion whereas the gross income method with the 50 percent limitation requires two computations.

It eliminates 1913 and discovery values as a basis for percentage depletion.

The method has proved practicable in the application of the Canadian law which uses a method similar to the first plan for metal mines and a fixed rate per unit of products sold in the case of coal mines.

"Bituminous coal mine operators have not received the relief given other mine operators," says the report. "The coal industry has been profitable only in a few years and is now in a condition as depressed as agriculture. The present system results in taking away from the bituminous coal industry a large proportion of its profits in taxes in the infrequent year of prosperity. The substitute method is desirable."

While the report indicates a preference for the second plan, Mr. Parker suggests careful analysis of other methods. The report does not consider net losses, and distribution of depletion between lessor and lessee as the mine ore problems can be solved if a sound depletion method can be devised. It is recommended that if any plan of computing depletion is adopted based on a percentage of net income from property, that both 1913 depletion and discovery depletion be eliminated in the interest of substantial simplification. As to the difficulty of determining net income from the property, the report says "this argument does not appear to be supported by actual facts," as the present law, section 114-B-2 requires such a determination by providing that the allowance for discovery value of mines shall not exceed 50 percent of the net income from the property; similar limitations were contained in prior revenue laws, and no complaint has been made that the net income could not be determined. It is also said that the method of bookkeeping by mining companies will show net income from this source without difficulty. Mr. Parker suggests that the bureau and taxpayers test these methods by applying them to actual conditions.

LEGISLATIVE REVIEW
(*from page 803*)

books and documents as may be necessary for enjoyment, control, use, administration and disposition of the lands. All laws in force on the date of the approval of the act relating to the entry of the public lands within the states, and all other laws inconsistent with this act are repealed, except that such laws are continued in force with respect to land excepted from the act. Public Lands.

Interior Branch

S. 1594, Mr. King (Dem., Utah)—This bill proposes to appropriate $1,500,000 for the establishment, not later than January 1, 1931, at a place designated by the President in one of the public land states, a branch of the Interior Department to which shall be transferred the following bureaus and services, together with the functions, powers, and duties pertaining thereto, and such officers and employes and such maps, files, plats, and other records as, in the opinion of the Secretary of the Interior, are necessary for the proper administration of the affairs thereof: General Land Office, Bureau of Mines, Geological Survey, Bureau of Reclamation, Bureau of Indian Affairs, and National Park Service. Such branch office shall be under the direction of an official of the Interior Department designated by the Secretary.

The bill abolishes the Forest Service of the Department of Agriculture and transfers its duties to the Interior Department, and administration of its affairs by the branch office in the west. Public Lands.

Magma Copper Plans To Erect Hospital

The Magma Copper Company is planning the erection of a new hospital at Superior, Ariz., to replace the dispensary which was damaged by fire some time ago. The new building will be of either tile or brick construction. The work of constructing the new building will be begun as soon as possible.

United Verde Announces $2,000,000 Improvement Program

Expenditure of $2,000,000 by the United Verde Copper Company, of Jerome, Ariz., in an improvement program which is expected to carry on over the next three years, has been announced by W. V. DeCamp, general mine superintendent. The program calls for the construction of a combination shaft which will extend from the 3,000-ft. level to the surface.

A mine fire during February and March at the Verde property was followed by a cave-in which effected a large area of the mine and is in a measure responsible for the proposed improvement program. The management, however, has announced that the anticipated developments of the property have caused the decision for the installation of the combination shaft.

Construction of the shaft will be started soon, it was announced, and will involve the removal of one of the shovel dumps, amounting to approximately a half-million tons of material. The shaft is designed to come through to the surface in the vicinity of the V. T. and S. depot on the 300 level. When this shaft is completed a change room will be erected on the 300 level and both the ore and material hoists installed at the surface.

The complete shaft installation and other proposed improvements will require approximately three years to complete. This program in addition to the shaft includes the removal of the dump, hoist installation and complete concreting of the shaft.

While the new shaft will be the major improvement carried on by the United Verde, considerable other development is included in the program. Numerous machinery adjustments will be made and new equipment added to take care of the increased production when the shaft is completed and underground surveys made.

In the meantime the company will operate as usual at its property with the exception of the points between the 1,200 level and the surface which must be abandoned during the period of improvement.

Sheldon Mining Corp. Takes Over Humboldt Copper Smelter

The Sheldon Mining Corporation which recently made an initial payment on a majority of the stock of the Southwest Metals Company, has taken possession of the latter company's smelter and plant at Humboldt, Ariz., with Superintendent George D. French in charge.

Transfer of the smelting plant is the first step, it is announced, in the plans for reopening the smelter for custom ores, and to handle ore being developed in the Sheldon properties at Walker and in the Blue Bell and DeSoto mines, formerly operated by the Southwest Metals Company but now under direction of the Sheldon Company.

The smelter will be ready to resume operations early in December. It has been closed since in 1927 when the low copper price made its operation impossible without loss.

Prior to the war the Humboldt Smelter was operated by the Arizona Consolidated Smelter Company and during the war period it ran full blast. Then copper prices dropped and it was necessary to close down. Southwest Metals then reopened it but in 1927, low copper prices again caused its doors to close.

Empire Star Buys 6,000-Ft. Tram

The Empire-Star Company has purchased the 6,000-ft. tram line formerly used by the Mason Valley Mines Company, near Yerington, Nev., and will use the equipment for transportation of ore from the North Star mine to the Empire mill. For several weeks the company has been using trucks in ore movements; but this method was found unsatisfactory. Eighty stamps are dropping at the Empire mill. Reports are current here that the North Star plant is to be dismantled. Development of good ore in both properties continues.

American Metal Company, Ltd.—A Correction

In our September issue there appeared a report to the effect that the American Metal Company, Ltd., had purchased molybdenum properties near Pitkin, Colo. Upon further investigation we find this to be untrue, and we take this opportunity to make a correction on behalf of the American Metal Company.

Gold, Silver, Copper, Lead, and Zinc Mined in New Mexico in 1928

(Final figures by Chas. W. Henderson, United States Bureau of Mines)

County	Gold* Fine ounces	Silver* Fine ounces	Copper Pounds	Lead Pounds	Zinc Pounds	Total value
Catron	202.64	16,800	17,000	.....	.....	$16,465
Colfax	893.78	145	.....	.....	.....	18,561
Dona Ana	.68	3,959	39,000	105,897	.....	14,088
Grant	5,625.09	153,453	81,131,090	2,822,328	15,512,000	12,998,855
Guadalupe	.....	2,359	1,200,000	.....	.....	174,180
Hidalgo	10,530.61	122,171	4,681,243	754,551	.....	1,007,020
Lincoln	.....	253	1,118	10,535	.....	920
Luna	4.11	188	.....	9,000	.....	717
Otero	198.53	858	80,243	287,000	.....	32,807
Sandoval	.....	29	6,500	.....	.....	953
San Miguel	14,981.59	495,980	2,120,000	10,385,000	46,410,000	4,338,436
Santa Fe	202.79	6,759	257,639	98,535	145,000	59,806
Sierra	168.59	6,754	5,403	146,448	.....	16,708
Socorro	95.78	16,183	128,327	991,207	339,000	108,095
Torrance	8.22	1,952	187,083	.....	.....	28,252
Total, 1928	32,912.41	827,793	89,854,646	15,610,501	62,406,000	†18,815,863
Total, 1927	29,241.87	890,083	74,251,863	16,052,855	59,603,000	†15,662,076
Increase or decrease from 1927	+3,670.54	—62,290	+15,602,783	—442,354	+2,803,000	+3,153,787

* Includes placer production: Gold 65.16 fine ounces; silver 17 fine ounces. † Average value of metals: Gold $20.671835 per ounce; silver $0.585 per ounce; copper $0.144 per pound; lead $0.058 per pound; zinc $0.061 per pound. ‡ Average value of metals: Gold $20.671835 per ounce; silver $0.567 per ounce; copper $0.131 per pound; lead $0.063 per pound; zinc $0.064 per pound.

California Rand Silver Mine Sold

The equipment and realty of the once famous silver mine of California, Rand Silver, Inc., at Randsburg, has been sold to Henry W. Klipstein, presumably for the H. W. Gould Mining Company of San Francisco, operating extensively in Nevada, the sale price being reported at $53,000.

The new owners are in control of the property and will take steps to resume operations immediately, it is said. Production will be carried on by leasers, but it is reported that the purchasers will also map out a development program in an extensive search for new ore, and that in addition they may negotiate for adjoining holdings with a view to creating a consolidated property of wider area.

The mine directors confirming the sale were Alfred Harrell, J. A. Hughes, Ben H. Sill, Dwight L. Clarke, and Myron Jameson.

The California Rand Silver was discovered in the spring of 1919. Work of development was begun in June of the same year, and in September the company was incorporated.

Tri-State Operators To Meet October 7

The annual meeting of the Tri-State Zinc and Lead Ore Producers' Association will be held at the Picher, Okla., offices of the association on Monday, October 7, at which time directors for the ensuing year will be elected and a resume of the different activities of the organization will be given.

Directors whose places are to be filled include Fred N. Bendelari, Consolidated Lead and Zinc Company; Frank Childress, Skeleton Lead and Zinc Company; S. H. Davis, Century Zinc Company; C. F. Dike, Interstate Lead and Zinc Company; A. M. Gaines, New Chicago Mines Company; P. W. George, Federal Mining and Smelting Company; W. T. Landrum, Cortez-King Brand Mines Company; T. F. Lennan, Quapaw Mining Corporation; Charles A. Neal; M. F. Owens, Black Eagle Mining Company; George W. Potter, Eagle-Picher Lead Company; George A. Pearson, Lawyers Mining Company; George Provine, Tulsa Lead and Zinc Company; J. F. Robinson, Commerce Mining and Royalty Company, and Edgar Z. Wallower, Evans-Wallower Zinc Company.

Officers for the coming year will be elected by the newly elected board of directors some time later in the week. Present officers of the association are Childress, president; S. H. Davis, first vice president; Edgar Z. Wallower, second vice president; Charles A. Neal, treasurer; and M. D. Harbaugh, secretary.

Two Phelps Dodge Branches Make Perfect Safety Records In August

Two of the five branches of the Phelps Dodge Corporation made perfect records in the prevention of lost time accidents during the month of August.

The Morenci and Old Dominion units were the two branches to chalk up the perfect score, tying for first place. The Copper Queen division, employing as many men as both of the record-making branches, came second with five lost-time accidents.

The Moctezuma unit at Nacozari, Sonora, Mexico, took fourth place with four mishaps necessitating time lost by the injured employes, and the Stag Canyon branch in New Mexico came last, with three.

The report for August showed a continuance of the lowering of time-lost accidents among the branches.

Figured on the basis of 1,000 shifts worked, the rating of the Copper Queen for August was .056; for the Moctezuma, .073 and for the Stag Canyon unit, .207.

The Morenci branch retains its lead in the safety contest for the year to date with a rating of .010, figured on the basis of 1,000 shifts worked. The Moctezuma branch is in second place with an average of .036, only two points lower than the Copper Queen in third place with .038. The Old Dominion is in fourth place with a score of .045 and the Stag Canyon last with .116.

Daily Zinc Output of World Up In August

Daily production of zinc in the world increased 13 tons during August, compared with the average daily rate of output in the month preceding, according to the American Bureau of Metal Statistics. The average daily production for the initial eight months this year was 4,423 tons, against 4,308 tons for the entire year of 1928.

Total production of world zinc last month amounted to 136,406 tons, compared with 136.018 tons in July and 129,347 tons in the similar month a year ago. Average daily production last month was 4,400 tons, against 4,387 tons in the preceding month and 4,169 tons in August, 1928.

United States production of zinc in August aggregated 55,290 tons, compared with 54,441 tons in the preceding month.

Aggregate output of zinc in the world in the first eight months this year was 1,074,424 tons, compared with 1,308,302 tons in the corresponding months of last year. The average monthly output so far this year has been 134,303 tons.

Anaconda Official Takes Position With African Company

Charles R. Wraith, assistant superintendent of the Anaconda Reduction Works, of the Anaconda Copper Mining Company, will leave October 15 to become manager of the concentration and smelting departments of the Roan Antelope Mining Company of Rhodesia, in southern Africa. Mr. Wraith's resignation from his position in Anaconda was announced the latter part of September.

A graduate of the Colorado School of Mines, Mr. Wraith ranks high as a metallurgical engineer. He has been connected with the reduction works in Anaconda for the past 16 years and for the last three years has occupied the position of assistant superintendent.

During the World War he served with considerable distinction in the department of gas development and was awarded the rank of major.

Mine Production of Gold, Silver, Copper, Lead and Zinc in Nevada in 1928

(In terms of recovered or recoverable metal)

Advance figures by C. N. Gerry, of the United States Bureau of Mines

County	Number of producers	Ore treated Short tons	Gold* Fine ounces	Silver* Fine ounces	Copper Pounds	Lead Pounds	Zinc Pounds	Total value
Churchill	4	625	138.35	4,687	1,112	219,156	.....	$18,473
Clark	20	13,059	749.52	27,805	118,085	2,220,320	1,425,285	264,485
Douglas	1	250	.15	12	7,527	.....	.....	1,094
Elko	31	85,990	28,647.48	474,601	457,297	2,677,446	.....	1,090,981
Esmeralda	37	301,307	25,273.23	796,074	2,233	184,506	.....	999,170
Eureka	8	57,173	2,715.72	816,512	51,199	1,296,707	.....	616,380
Humboldt	11	606	1,071.94	20,378	989	6,785	1,248	34,692
Lander	27	37,514	1,070.54	604,153	3,113,822	375,791	.....	845,745
Lincoln	15	68,311	1,120.85	671,473	2,100,779	7,652,815	5,370,180	1,489,938
Lyon	17	565,508	2,274.25	68,365	11,005,253	4,902	.....	1,672,047
Mineral	36	2,564	2,459.00	45,390	22,971	51,000	.....	83,944
Nye	66	83,875	28,444.98	1,414,285	2,020	64,538	.....	1,419,401
Ormsby	1	20	2.66	49	991	.....	.....	227
Pershing	15	30,847	2,085.74	252,881	5,314	77,269	.....	196,298
Storey	19	76,441	8,728.88	37,679	5,709	172	.....	203,316
Washoe	14	242	220.45	2,295	5,503	184	.....	6,704
White Pine	37	5,733,101	70,154.05	244,435	141,976,079	915,853	.....	22,000,881
Total 1928...	359	7,057,433	175,157.97	5,481,574	158,876,883	15,747,444	6,796,713	†31,033,776
Total 1927...	409	5,531,152	150,346.16	5,397,179	120,259,276	15,784,818	6,344,523	‡23,322,589

* Includes placer production. † Average value of metals: Gold, $20.671835 per ounce; silver, $0.585 per ounce; copper, $0.144 per pound; lead, $0.058 per pound; zinc, $0.061 per pound. ‡ Average value of metals: Gold, $20.671835 per ounce; silver, $0.567 per ounce; copper, $0.131 per pound; lead, $0.063 per pound; zinc, $0.064 per pound.

Phelps Dodge To Construct Experimental Leaching Plant and Mill

The Morenci branch of the Phelps Dodge Corporation, during the coming year, will construct a 50-ton daily capacity leaching plant and a 100-ton mill in the vicinity of Bunker Station, between Clifton and Morenci, Ariz., with construction work to start January 1, according to an announcement by Frank Ayer, manager.

The decision to erect the plant is the result of experiments conducted in Douglas during the past year in a small test leaching plant. Morenci ore, in small quantities, was shipped to Douglas for leaching, and comparisons in the saving by the leaching process were made with concentration and smelting as is carried on in this district.

It is now the policy to conduct these experiments on a larger scale in a plant during the coming year and to thoroughly demonstrate the best and most economical method of treating Morenci ores.

The leaching plant at Bunker will be under the direction of Mr. LeGrande, consulting engineer for the corporation.

California Tungsten Mine Sold

A dispatch from Bishop, Calif., says the Tungsten Corporation of America has announced purchase of the Bishop tungsten properties, near there, and five tungsten claims in the Atolia district of Kern County. The Bishop mine contains an immense tonnage of low grade ore which is mined by the glory hole method. The mill is treating 175 tons of ore daily and producing 12 to 15 tons of tungsten concentrates monthly. The management states capacity of the plant is to be raised to 500 tons daily.

Seven Mines of Tri-State District Go Eight Months Without a Lost-Time Accident

Seven mines of the Tri-State district have worked through the first eight months of 1929 without a lost-time accident. Six of these properties belong to the Commerce Mining and Royalty Company and the other to the Evans-Wallower Lead Company.

The properties that have a clear record for 1929 follow:

Beaver, Grace Walker, Jay Bird, Scammon Hill, Wilbur and Webber of the Commerce Company.

Mine No. 24 of the Evans-Wallower Company.

Forty-one mines of 19 companies, reporting to the accident prevention department of the Tri-State Zinc and Lead Ore Producers' Association, worked throughout the month of August without a lost-time accident.

In the week ending September 21, 68 mines of 19 companies in the district, worked 26,247 man-shifts without a lost-time accident.

Data On Mineral Resources of Nevada To Be Published

A great deal of the data gathered by the engineering staff of the Mackay School of Mines of the University of Nevada, of mineral resources of the state is to be published soon, according to Professor John A. Fulton, director. The field work has been completed by the school instructors for the state mining bureau and what spare time is available after the fall term opens at the university will be devoted to preparation for printing.

It is the purpose to issue two bulletins, one covering the mineral resources of the state tributary to the Boulder Canyon dam, the other devoted to mercury. Two parties composed of members of the Mackay School of Mines faculty have spent most of the summer in field work and have gathered information at first hand of the mineral resources.

Large Enrollment At Montana School of Mines

At the end of the first week of registration at the Montana State School of Mines, 126 students were enrolled, the largest enrollment in the past nine years, Dr. Francis A. Thomson, president of the school, announced. Late enrollments and second semester registrations are expected to increase the figure to the largest in the history of the school, he said.

This group of men, comprising one of the United Verde Copper Company's divisions, has worked without a lost-time accident since June 6. On September 6 they had put in 14,000 man shifts. There are 176 men in the crew, and this is the best record so far established by any one division. The bosses may be seen in the front standing near the center. From left to right they are: Robert Kelly, John Blazina, John Rice, John Eddy, shift bosses, and Walter Mutz, division foreman

CLEVELAND-CLIFFS STAGES SAFETY PICNIC FOR EMPLOYES

More than 10,000 men, women and children were entertained at The Cleveland-Cliffs Iron Company's Labor Day safety picnic, held at Legion Park, Ishpeming, Mich., September 2. The event was an outstanding success, and illustrates in a practical way the work that this organization is doing to promote the best industrial relations.

The opening ceremony at 10.30 a. m., was presided over by S. R. Elliott, general manager of the company, under whose direction the picnic was arranged. An invocation was followed by a flag-raising ceremony by American Legion members employed by Cleveland-Cliffs.

Starting at 11 o'clock, the program was filled with sporting events, not only for the men employed by the company, but for their wives and children. Baseball games between teams representing the mines and the shops were played throughout the day and there were many other features in the way of entertainment and unique contests.

Music during the day was provided by the Gwinn and Negaunee bands. Vocal selections were rendered by a trio and a male quartette.

One of the highlights of the afternoon program was the address by William G. Mather, president of the company, who spent Saturday and Sunday in Ishpeming. Mr. Mather bespoke his and the company's gratification for the splendid relations between the men and the company and the interest that was being shown.

"We are constantly thinking of so arranging your occupation that the possibilities of injuries or of contracting any disease be minimized," said Mr. Mather. "The officers of the company greatly appreciate the loyal and intelligent cooperation of employes, without which the splendid advance of recent years in reducing accidents could not have been achieved. I hope you feel that it is not in a spirit of boastfulness, but with justifiable pride that we say it has always been the policy of The Cleveland-Cliffs Iron Company to take whatever steps are necessary to protect the lives and welfare of its employes. I do not recall that any company preceded us in having a thoroughly organized safety department which has kept abreast of the most advanced practice in Europe and America in the application of methods for combating accidental injury to our men. No mine is opened; no machinery is bought without including in its specifications all safety plans which can be thought of after general discussion among the officials without regard to expense.

"It was said of George Washington that he was first in war, first in peace and first in the hearts of his countrymen. The Cleveland-Cliffs Iron Company is not supposed to be first in war and peace, but we were first in mining Michigan ore and we want to be first in the hearts of our employes."

Employes of the Morris-Lloyd mine, were presented with gold safety buttons by Mr. Mather, for their excellent record of 445 days, with a total 82,102 manshifts worked without sustaining a lost-time accident. Superintendent Charles Stakel and Captain William Nault led the group of bosses to the platform, where Mr. Mather pinned on the buttons. The other employes were given their buttons at the registration tent.

In his address of welcome to the employes and their families, S. R. Elliott, general manager of the company's mining department, told the men, women and children that the picnic was given in recognition of the cooperation which Cleveland-Cliffs workers have given the company in preventing accidents in mining and other operations and he appealed to all workmen to do even better safety work in the future.

"Last spring when the men at the Morris-Lloyd mine established a year's no-lost-time accident record," said Mr. Elliott, "it was suggested that the company give these employes a picnic in recognition of their splendid accomplishment. Your safety inspector, Mr. Connibear, told me he thought this would be unfair to our men at the other mines, all of you having worked hard for good safety records. He recommended a safety picnic for all of our employes and their families. I heartily agreed with him and our president, Mr. Mather, approved of the plan. This safety picnic, therefore, is being held to show our appreciation for the splendid cooperation which has been given by all of our employes in this very important work of preventing accidents. Working together in this spirit of cooperation, outstanding records in safety have been achieved since this campaign started and it shows clearly that the employes of the company have kept their pledge."

The distinction of being in the service of the company the greatest number of years was awarded to Michael McNamara, whose service totalled 46 years and 11 months.

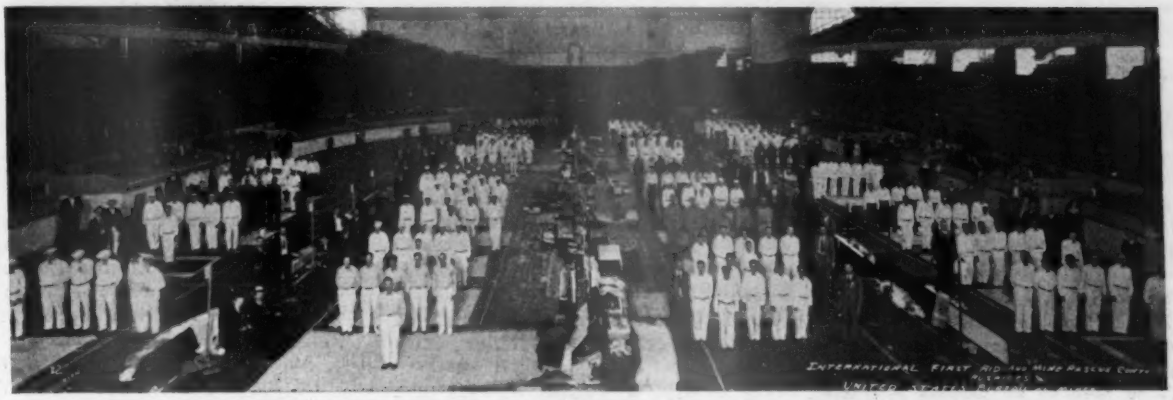
Mr. McNamara was born in 1867 and started to work for the company on August 2, 1882,

Refreshments and a picnic lunch were provided by the company.

S. R. Elliott, manager of the Mining Dept., delivering the welcome address.

The formal opening of Cleveland-Cliffs safety picnic.

William G. Mather, president of Cleveland-Cliffs, addressing the gathering.



First aid teams at the International meet, just before the contest

UTAH COPPER COMPANY TEAM TAKES FIRST HONORS IN INTERNATIONAL CONTEST

A Utah team, representing the Utah Copper Company, from Bingham Canyon, won first honors at the International First Aid and Mine Rescue Contest, held at Kansas City, Mo., September 12, 13 and 14, with an average of 98.95 percent. The mine rescue contest was won by team No. 1 of the Maryland Division of the Consolidation Coal Company, from Frostburg, Md. First place in the combination contest, involving both first aid and mine rescue, was taken by the Northwestern Improvement Company, of Roslyn, Wash.

There were 40 first-aid teams entered in the competition from 18 different states, and 9 mine rescue squads from 6 states.

In the first aid division the winning teams were:

First. Utah Copper Company, Bingham Canyon, Utah.

Second. Colorado Fuel and Iron Company, Pueblo, Colo.

Third. Pickands Mather & Company, Ironwood, Mich.

In the mine rescue division, winning teams were:

First. Consolidation Coal Company, Inc., Frostburg, Md.

Second. Northwestern Improvement Company, Roslyn, Wash.

Third. Madison Coal Company, Mount Olive, Ill.

Awards in the combination mine rescue and first aid contest were:

First. Northwestern Improvement Company, Roslyn, Wash.

Second. Madison Coal Company, Mount Olive, Ill.

Third. Buckeye Coal Company, Nemacolin, Pa.

State first aid honors were awarded as follows:

Arizona—Phelps Dodge Corp., Morenci.

Colorado—Colorado Fuel & Iron Co., Pueblo.

Illinois—Peabody Coal Co., Kincaid.

Iowa—Consolidated Ind. Coal Co., Mine No. 2, Melcher.

Kansas—Shell Petroleum Corp., Arkansas City.

Louisiana—Standard Oil Co., Batonrouge.

Maryland—Consolidation Coal Co., Frostburg.

Michigan—Pickands Mather & Co., Ironwood.

Montana—Anaconda Copper Mining Co., Greatfalls.

Oklahoma—Commerce Mining & Royaltty Co., Miami.

Pennsylvania—Pittsburgh Coal Co., Mansfield Mine, Pittsburgh.

South Dakota—Homestake Mining Co., Lead.

Texas—Freeport Sulphur Co., Freeport.

Utah—Utah Copper Co., Bingham Canyon.

Virginia—Stonega Coke & Coal Co., Roda.

Washington—Northwestern Improvement Co., Roslyn.

West Virginia—Fordson Coal Co., Twin Branch.

Kentucky—Northeast Coal Co., Paintsville.

The contests were conducted under the auspices of the United States Bureau of Mines with the cooperation of a number of mining, industrial and civic organizations.

The mine rescue teams which were entered in the Kansas City Meet

Evans Wallower Expands

Directors of the Evans Wallower Lead Company have authorized the immediate drawing of plans for the erection of an electrolytic lead-smelting plant with a daily capacity of 50 tons at East St. Louis. Experimental work shows that not only will the electrolytic lead plant permit of economic handling of low-grade ores, but in addition the product can be used at the lead oxide plant at Charleston, W. Va.

Carnegie Advisory Boards to Discuss Metallurgy Research and Steel Problems in Open Meeting

Progress being made in metallurgical research and problems vital to the steel industry will be discussed at the third open meeting of the Metallurgical and Mining Advisory Boards to the Carnegie Institute of Technology and the United States Bureau of Mines to be held on October 18 in the auditorium of the United States Bureau of Mines, in Pittsburgh.

Leading metallurgists and steel research engineers from all over the country will attend the all day meeting which will be open to all persons interested. Illustrated progress reports will be given by research engineers of the Carnegie Institute of Technology and the Bureau of Mines.

The morning session will begin at 10 a. m., when Dr. V. N. Krivobok, associate of the Bureau of Metallurgical Research, Carnegie Institute of Technology, and Dr. C. H. Herty, Jr., physical chemists at the Bureau of Mines, will offer an illustrated report on "Case Carburizing Research."

Dr. F. M. Walters, Jr., director of the Bureau of Metallurgical Research, Carnegie Institute of Technology, will deliver a report on the preparation of iron-carbon-manganese alloys, a study that has occupied his attention for some time. Dr. J. B. Friuf, a third member of the Carnegie research workers will deliver a talk on the preparation of pure manganese, a process which was worked out in the Carnegie laboratory.

"The Physical Chemistry of Steel Making" will be the topic during the afternoon meeting. Dr. Herty, of the Bureau of Mines, will give an illustrated report on the fundamental studies carried on in the Bureau's laboratories. Later in the meeting he will offer another report on plant research in open hearth treatment.

F. N. Speller, director, Department of Metallurgy and Research, National Tube Company, who was elected chairman of the boards last year, will preside at the day sessions. A. C. Fieldner, chief engineer of the Experiment Stations Division of the U. S. Bureau of Mines in Washington, D. C., will make the introductory address at the afternoon session.

The various reports will be interspersed with discussions. Among the speakers included in these discussions will be: O. E. Harder, director of the Department of Metallurgy, University of Minnesota; W. J. Merten, metallurgical engineer, Westinghouse Electric and Manufacturing Company, Pittsburgh; Louis Jordan, chief of the Section of Chemical Metallurgy, Bureau of Standards; Dr. H. W. Gillett, director of the Bartelle Memorial Foundation; P. H. Brace, section engineer, Metallurgical Research Department, Westinghouse Electric and Manufacturing Company; John A. Mathews, vice president, Crucible Steel Company of America.

The advisory boards were organized in 1923 by Dr. Baker "for the purpose of bringing the department of metallurgy at the Carnegie Institute of Technology in closer touch with the industries and to help the department to increase its usefulness and service."

R. S. Dean Appointed Chief of Bureau of Mines, Metallurgical Division

R. S. Dean, of Chicago, Ill., has been appointed as chief engineer of the Metallurgical Division of the United States Bureau of Mines, effective November 1. Mr. Dean has for the past 10 years been associated with the Western Electric Company at their Hawthorne plant in Chicago, where he has been in charge of metallurgical development.

Mr. Dean was born at Rolla, Mo., August 23, 1897. He was educated in the

R. S. Dean

public schools of Rolla and graduated from the School of Mines and Metallurgy of the University of Missouri in 1915. He pursued graduate study in physical chemistry at that school and at Harvard University and the University of Chicago. He taught metallurgy at the University of Pittsburgh and at Armour Institute of Technology, Chicago, and was engaged on metallurgical research for short periods with the Anaconda Copper Mining Company and the American Zinc, Lead and Smelting Company, before his association with the Western Electric Company.

Mr. Dean's activities in the metallurgical field have been extensive, and papers published by him and his associates cover investigations in flotation, chemistry of ore deposits, electrolytic refining, theory of metallic hardening, copper wire studies, and alloy studies of various kinds. He is perhaps best known for his work on the dispersion hardening of lead alloys, which attracted widespread attention.

He has been active in technical society work and serves on the Papers Committee and the Douglas Medal Award Committee of the American Institute of Mining and Metallurgical Engineers, and on the executive committee of the Chicago section of that Institute. He has represented the Western Electric Company for several years on a number of committees of the American Society for Testing Materials. He is a member of the American Chemical Society, the British Institute of Metals and the American Society for Steel Treating. In 1924 he received the Chicago section award for advances in metallurgy.

In his association with the Bureau of Mines, Mr. Dean will have general supervision of the extensive program of metallurgical research conducted by the Bureau at its various experiment stations located in the principal mining districts of the country.

Geological Survey Announces Changes

Two important changes in the administrative officers of the Geological Survey have been announced. These result from the resignations of Col. Claude H. Birdseye, chief topographic engineer, who is leaving the Government service to accept a commercial position, and of Col. Glenn S. Smith, as engineer in charge of the Atlantic Division of the Topographic Branch.

Effective September 10, the Secretary of the Interior has appointed John G. Staack as chief topographic engineer, and Albert Pike as division engineer. Mr. Staack has served continuously in the Geological Survey for 25 years, except while for two years a captain in the Corps of Engineers during the World War. He has had wide field experience, his assignments covering the entire field of topographic and geodetic engineering in many parts of the United States, and also administrative experience as chief of the Great Lakes section with supervision over the mapping in four states. Mr. Pike likewise has had long service in the Topographic Branch and was Captain of Engineers in the World War; he has shared largely in the supervision of the Atlantic Division, of which he now takes charge.

Colonel Smith will retain a part-time connection with the Geological Survey to serve as special representative of its director and of the Secretary of the Interior in important matters, and will be acting chief topographic engineer until Mr. Staack can complete his field assignments and assume his new responsibilities.

Glen Alden Coal Buys Lehigh & Wilkes-Barre

One of the largest deals in anthracite property in years was made recently, when the Glen Alden Coal Company announced it would take over the physical property of the Lehigh and Wilkes-Barre Coal Company, subject to approval by the stockholders of both concerns.

The Glen Alden Coal Company, which is closely identified with the interests of the Delaware, Lackawanna and Western Railroad Company, is one of the largest producers of hard coal and with the acquisition of the Lehigh and Wilkes-Barre mines it is said it would become the largest, based on the annual production of coal during recent years.

The official announcement of the deal and the only word given out by either company came from W. W. Inglis, president of the Glen Alden Company. It said:

"Negotiations have been completed whereby, subject to the approval of the stockholders of both companies, the Glen Alden Coal Company will take over the physical property of the Lehigh and Wilkes-Barre Coal Company located in the state of Pennsylvania, paying therefor 676,700 shares of Glen Alden Company stock."

The price of the stock was not mentioned nor was there anything forthcoming as to how the tonnage of the Lehigh and Wilkes-Barre Company would be divided among the railroads.

The Lehigh and Wilkes-Barre Corporation is the present owner of the Lehigh and Wilkes-Barre Coal Company stock, having purchased it from the Reynolds syndicate of New York, which in turn acquired it from the Central Railroad Company of New Jersey about six years ago. The price paid the Jersey Central at that time was $32,490,980. The Jersey Central was compelled to divest itself of the coal property by decree of the United States Supreme Court.

According to the statistics of the State Bureau of Mines, the Glen Alden production in 1928 was 8,442,559 tons and the Lehigh and Wilkes-Barre output 5,267,854, or a total of 13,710,413 tons for the two companies, as against 9,188,435 tons for the Reading Company, generally regarded as the largest anthracite producer.

Fourteen Glen Alden Company collieries, employing approximately 20,000 persons, are affected by the merger. The collieries are: Stokes, Diamond, Hyde Park, Archbald, Pines, Taylor, Baker, all in Lackawanna County; Pettebone, Woodward, Avondale, Truesdale, Grand Tunnel, Loomis and Bliss in Luzerne County.

The Glen Alden Coal Company's largest breaker is the Baker, which is located at Bellevue and said to be one of the most modern coal sizing plants in the anthracite region. In addition the company operates a large power house along Susquehanna River in Hanover township, close to the Loomis colliery.

Lehigh & Wilkes-Barre Coal Company owns 10 collieries, 9 of them in the Wyoming Valley and 1 at Audenreid. The Lehigh & Wilkes-Barre collieries are: Honeybrook No. 4 at Audenreid, Carbon County; South Wilkes-Barre, Hollenback, and Stanton, all in Wilkes-Barre City; Lance No. 11 and Nottingham, in Plymouth; No. 9 at Sugar Notch; Buttonwood No. 22 in Hanover township; Wanamie No. 18, at Wanamie, Newport township, and Maxwell No. 20, at Ashley.

This company also is the owner of large coal reserves in Newport and Hanover townships and in addition operates a number of coal tracts under lease.

The company is constructing a modern breaker at Lance No. 11 operation in Plymouth, and this is expected to be ready within a few months.

M. A. Hanna Co. To Reopen Coal Mines In Eastern Ohio

The M. A. Hanna Company, of Cleveland, of which the Wheeling and Lake Erie Coal Mining Company and the Massillon Coal Mining Company are subsidiaries, has set out to put the mines in eastern Ohio to work, that miners in that section may have employment. The Hanna concern has taken over the management and sales agency for the Jefferson Coal Company which has been operating one of its three mines on part time. It is reported the new management will put the mine on full time and open up one of the other mines, paying $5 a day. This course of the Hanna concern is carrying out a policy expressed by the management two years ago.

Colonel Walter Herd Dead

The mining profession of Nova Scotia was shocked to learn of the sudden death of Colonel Walter Herd, which occurred at Chester, Nova Scotia, on August 23. After a prolonged illness, from which he apparently was making progress towards recovery, he suffered a relapse and passed quite suddenly.

Colonel Herd had been associated with the coal mining industry of this province since 1911, and for the last decade held the position of chief mining engineer for the British Empire Steel Corporation. He was born in Kirkcaldy, Scotland, in 1883, and received his technical education in Heriot Watt College, Edinburgh, and his early mining experience in the coal mines of Great Britain.

Enlisting in the early stages of the war, he was retired with the rank of lieutenant-colonel at its close. His ability as an engineer was early recognized, and won for him rapid promotion.

His success in his chosen profession was in marked degree. The forward and progressive steps in coal mining in this province have been due to his mastery of technic, initiative, and broadness of vision.

He was a valued member of many professional societies, and contributed freely to the transactions. His latest contribution being his paper on "Bumps in No. 2 Mine, Springhill, N. S.," presented to the American Institute of Mining and Metallurgical Engineers at their February meeting this year.

W. Va. Coal & Coke Plant Being Remodeled

Considerable progress is being made in remodeling the tipple at No. 5 mine of the West Virginia Coal & Coke Company, at Omar, W. Va., in order to increase the mine's production to 3,000 tons per day.

Much of the work necessary for the rearrangement of the tracks outside of the tipple is completed. The improvements will include a rotary dump of the newest design, run-of-the-mine belt conveyor and a tunnel to connect with rich coal deposits on Pine Creek.

It is expected that most of the work will be completed by the first of next year.

Kentucky Holds First Aid Meet

Scoring 598 out of a possible 600 points, the team of the Northeast Coal Company from Thealka, Ky., won first place in the state-wide First Aid Meet held August 31 at the University of Kentucky stadium under the auspices of the Kentucky Department of Mines and participated in by 300 miners.

Second place was won by the Consolidated Coal Company, Jenkins, Ky. This team scored 597 points. Third place went to the team representing the Blackwood Coal & Coke Company, Pardee, Va., with 596 points, and the Lynch, Ky., team of the United States Coal & Coke Company won fourth honors with 595 points. The team representing the Clover Splint Coal Company, Closplint, Ky., won first place among the negro teams entered.

Anthracite Output Increased In August

A forecast made last month by Secretary of Mines Walter H. Glasgo, that the production of anthracite coal would be increased 20 percent in August over July was exceeded when figures compiled by the department showed that the gross tonnage mined in August was 4,-

855,000 tons, an increase of 25 percent over the 3,900,000 production of July. The June output was 4,000,000 gross tons.

A continued increase is expected by the Secretary who bases his opinion on the fall seasonal demand and employment reports of the Department of Labor and Industry.

George S. McCaa Appointed Bituminous Inspector of Pennsylvania

An August 8, Governor Fisher, appointed George S. McCaa a bituminous mine inspector of Pennsylvania. At that time and for five years previous thereto Mr. McCaa held the position of District Engineer of the U. S. Bureau of Mines, with headquarters at the Experimental Station in Pittsburgh. Mr. McCaa assumed his duties with the state September 16, and has been assigned to the thirteenth bituminous inspection district, with headquarters in Pittsburgh. He will be engaged in the inspection of mines in his district, the investigation of accidents, and all other duties required by law of a mine inspector, in addition to which he will serve in a consulting capacity, to other inspection districts in both the bituminous and anthracite fields, in connection with mine fires, explosions, first aid and accident prevention work and will give special attention to the subject of ventilation in gaseous mines.

Mr. McCaa is 45 years of age, a graduate of Lafayette College with the degree of mining engineer, and holds all official papers for both anthracite and bituminous mines, having had his first experience in mines in the anthracite field as a machinist, mine surveyor and mining engineer for 10 years, following which he served as mining engineer, insurance rating inspector, safety engineer and superintendent of mines in the bituminous field for 13 years, the last 5 years as District Engineer of the U. S. Bureau of Mines, making investigations and reports on mine fires, explosions and mine safety subjects, in connection with which work he has attended approximately 200 mine fires and explosions in all parts of the United States and Canada, about 30 of which have been in Pennsylvania.

New Commerce Director

William L. Cooper, of New York, has been nominated by President Hoover to be director of the Bureau of Foreign and Domestic Commerce. He will succeed Julius Klein, who has become Assistant Secretary of the Department of Commerce. At present Cooper is serving as Commercial Attache in the foreign service of the Commerce Department at London.

WEST VIRGINIA LEADS IN BITUMINOUS COAL PRODUCTION

For the second successive year West Virginia, in 1928, exceeding all other states in the production of bituminous coal, the total output for 1928, according to statistics published by the Bureau of Mines, amounted to 132,952,159 net tons as against 131,202,163 tons for Pennsylvania and 61,860,379 tons for Kentucky which ranked second and third respectively. When Pennsylvania's output of anthracite is included, however, the Keystone state is still far in the lead, her total production of coal of all kinds in 1928 being 206,550,232 net tons.

Although retaining its place as the leading bituminous coal producing state, production in West Virginia for 1928 shows a decrease of 8.4 percent when compared with that for the previous year. Nearly all districts shared in this decrease, although several counties, notably McDowell, Greenbrier and Raleigh, in southern West Virginia, show substantial gains, while Marion and Brooke counties in the northern part of the state show slight increases. Logan County still remains the principal producer in West Virginia with an output of 21,659,463 tons, or more than 16 percent of the total production.

The number of active coal mines of commercial size in West Virginia declined from 1,149 in 1927 to 980 in 1928. There was a corresponding reduction in the number of men engaged in the industry, the total last year being 111,733 as compared with 119,799 in 1927. The output per man per day, however, increased from 5.15 tons in 1927 to 5.35 tons in 1928.

Prices of West Virginia coal declined by an average of 13 cents a ton in 1928, reflecting the lessened activity which characterized the bituminous industry throughout the country during the year. The average price f. o. b. mines in 1928 was $1.59 per ton as against $1.72 per ton in the preceding year. The total value of the coal produced last year amounted to $211,480,000, a decrease of

Illinois Coal Production in 1928

Among the many industries of Illinois, coal mining ranks high in value of product. In 1928 the mines of the state produced coal to the value of $112,095,000. The average value per ton f. o. b. mine was $2, a decrease of $.16 in comparison with 1927. The average price obtained varied in different parts of the state. In Sangamon County, for example, it was $2.16, in Franklin County $2.05, in Williamson County $2.03, and in St. Clair County $1.72. These figures are averages for all coal sold, including 15.3 percent when compared with that of 1927.

screenings and run-of-mine as well as prepared sizes.

Labor disputes at a number of mines in the state, some of which were closed for five months or more, acted to reduce production in 1928, yet in comparison with 1927, when there was a general suspension, there was a substantial increase in output. The total quantity mined in 1928 was 55,948,199 net tons, an increase of 19.5 percent when compared with the 46,848,224 tons produced the year before.

Franklin County remained by far the largest producer in the state with a total output in 1928 of 13,944,000 tons. Next in total tonnage came Williamson County with 5,115,000 tons, followed by Macoupin with 4,650,000, Sangamon with 3,708,000, Saline with 3,645,000, Christian with 3,617,000, and Vermilion with 3,358,000. Coal was mined in 42 other counties, but none of them reached the 3,000,000-ton mark.

The average number of days worked by the mines increased from 114 in 1927 to 156 in 1928. The number of men employed, however, declined sharply, falling from 76,970 in 1927 to 64,266.

Coal Production in Ohio

The total quantity of coal produced in Ohio in 1928 amounted to 15,641,225 net tons. In comparison with the output for the previous year, the production in 1928 shows a decrease of 1.1 percent. This decrease was spread fairly evenly throughout the state with nearly all counties sharing proportionately. Belmont, Coshocton, Harrison, Tuscarawas, and a few of the smaller producing counties, however, showed an increase in output and partly offset the decrease in the other counties. Belmont County retained its position as the principal coal producer in Ohio, accounting for 3,824,710 tons, in 1928, or nearly a quarter of the total output.

The number of workers engaged in the coal mining industry of Ohio was reduced by 14,172 last year. The total reported employed in 1928 was 21,371, of whom 18,405 worked underground and 2,966 on the surface. In 1927 there was a total of 35,543 men employed. Steadier employment, however, was given to those remaining in the industry in 1928. The average number of days worked last year was 171, as against only 98 days in the previous year.

In 1928 the total value of the coal produced amounted to $26,439,000, as against $30,376,000 the year before, a decrease of 13.0 percent. The average price declined by 23 cents per ton, being $1.69 last year as compared with $1.92 in 1927.

Extensive Coal Deposits Found In Northern Canada

Discovery of extensive coal deposits, one of the few minerals hitherto unfound in Ontario, has been announced by Premier Ferguson.

A bed one mile long and a half mile wide, estimated to contain from 7,000,000 to 10,000,000 tons of lignite, a low-grade fuel, has been found along the Abitibi River, at Blacksmith Rapids, near Cochrane. He described the discovery as the most important mining development in Ontario in years.

Dr. W. S. Dyer, provincial geologist, who has spent three summers investigating the find, said the coal could be marketed at from $5 to $6 a ton, exclusive of freight charges. He said tests at the Dominion Laboratories at Ottawa showed that the coal, partially carbonized, can be used profitably by some of the large paper mills in the province.

Arizona Organizations Hold Mining Revival Meeting At Prescott

Despite the fact that Yavapai County, Ariz., is today the leading mining county of that great mining state, having 64 mines producing within its area, representing a total value in production of $26,750,353 in 1928, that district believes thoroughly in stimulating further its great industry and mineral assets. To that end the mining committee of the Yavapai County Chamber of Commerce, with the cooperation of the Arizona Industrial Congress, the Arizona Chapter of the American Mining Congress and the Arizona section of the American Institute of Mining and Metallurgical Engineers, on August 24, held one of the most successful mining revival meetings ever held in the Southwest, at Prescott. Yavapai and Prescott, the "Home of the Prospector," welcomed the prospector, miner and small mine operator to this meeting which was attended by over 300 individuals actively identified with the mining industry.

Geologists, operators of the larger companies, field men, engineers, metallurgists, rubbed shoulder to shoulder with the man from the hills. The purpose of the meeting, that of discussing the problems of the prospector and small operator, was carried out to the letter, and as a direct result of the same, renewed activity is apparent in many sections.

Papers presented at the meeting embraced every line of mining activity. Such a demand has been made for them, that hundreds of copies have been prepared and mailed. Those wishing copies may obtain same by writing to the mining committee of the Yavapai County Chamber of Commerce, at Prescott, Ariz.

Demonstrations in first aid, safe practices, and geophysical prospecting were given prominent places on the program, which embraced an intensive two days' study of the entire situation.

The meeting went on record asking the Arizona Congressional delegation to work to secure such legislation in Congress as will clarify the situation now existing relative to the incomplete provision of the present laws for the location of disseminated copper deposits and other blanket or flat lying veins or deposits of ore and especially those lying beneath an overburden of wash or other material. A request was made for additional and ample financial support of the Arizona Bureau of Mines, that even more worth while results may be obtained.

The meeting protested vigorously any proposed change in the freight rates and charges applicable to the transportation of non-ferrous metals and their products, as detrimental to the small operator. W. J. Graham, of Phoenix, was appointed chairman of a committee to organize small operators in gathering statistics to present before the Interstate Commerce Commission in opposition to any increase in freight rates on ore and mine products.

Other members of the committee named were Charles F. Willis, of Phoenix; L. V. Root, of Kingman, M. B. Elsing, of Bisbee; J. J. Keegan, of Globe; Hugo Miller, of Nogales, and H. A. Tedrow, of Walker.

West Virginia Holds "Safety Day" at Charleston

Attaining a score of 799 out of a possible 800 points, the Grant Town, W. Va., first aid team of the New England Fuel and Transportation Company, won first honors in the fourth annual West Virginia Safety Day contest held at Charleston September 7.

Another Marion County team representing the Consolidation Coal Company, Mine 32 team, from Shinniston, took second place with a total of 797 points. Other winning teams were Fordson Coal Company, Twin Branch; Consolidation Coal Company, Carolina, winner of last year's meet; Logan County Coal Corporation of Lundale, and Wyatt Coal Company, Laing.

In mine rescue contests, first place went to the Continental Coal Company Cass team which scored 98 percent in working out of problems prepared by the United States Bureau of Mines. These contests were held in a tunnel erected to resemble a mine mouth and filled by an explosion with poisonous gases. Second place in the rescue contests was won by the Davis Coal and Coke Company squad from Thomas with a score of 96 5/10 percent.

A short program of speech making preceded the contests. Governor Conley, who lauded Robert M. Lambie, chief of the State Department of Mines, for establishing the annual safety day, was the principal speaker. The principle of safety day, he said, has "gone forth to the other states and has practically spread over the entire nation." Other speakers included Col. W. M. Wiley, of Sharples, president of the Kanawha Coal Operators' Association, and J. G. Bradley, president of the West Virginia Coal Association.

Metal Exchange To Issue Statistics On Metals

The National Metal Exchange is preparing to compile and distribute more adequate statistics on metals than have been available heretofore, Erwin Vogelsang, president, has announced.

Mines Work Through August Without Accident

Three mines of the West Virginia Coal and Coke Corporation operated during the month of August without accidents. These mines were the Earling, Josephine and Leiter mines, all in West Virginia.

The last accident at the Earling operation was on July 17. This mine worked every day during the past month. The last accident at Josephine occurred on July 9.

The Leiter operation, while much smaller than some of the other mines, has had only one accident during the year and that occurred on May 20.

MANGANESE CONVENTION (from page 812)

Company, New York; O. D. Hutchens, president, Manganese Ore Co., Johnson City, Tenn.; Chas. W. Massie, secretary-treasurer, Hy-Grade Manganese Co., Inc., Woodstock, Va.; Joel Hurt, Jr., president, American Minerals Corp., Atlanta; Robert E. Dwyer, vice president, Anaconda Copper Mining Co., New York; H. A. Pumpelly, vice president, Domestic Manganese & Development Co., Owego, N. Y.; J. Carson Adkerson, consulting engineer, Washington, D. C.; Ottomar Stange, president, Stange Construction Co., Philadelphia; Herbert Wilson Smith, Union Carbide Co., New York; N. H. Mannakee, Bluefield, W. Va.; Gaston Scott, secretary to Governor of Alabama, Montgomery; D. H. McCloskey, Jersey City; W. R. Spencer, president, Luna Manganese Co., Jackson, Mich.; W. J. Stanton, vice president-treasurer, Cuban American Manganese Corp., New York; L. B. Miller, Cleveland; Carl Zapffe, Northern Pacific Railway Co., Brainerd, Minnesota; John Hickey, president, Moorlight Mining Co., Philipsburg, Mont.; E. A. Fritzberg, manager, Trout Mining Co., Philipsburg, Mont.; W. G. Rinehart, Batesville, Ark.; E. F. Rummel, Chicago, Milwaukee & St. Paul Ry., Chicago; C. G. Ewing, president, Philipsburg Mining Co., St. Louis; H. O. Flickinger, president, North Granite Mining Co., Philipsburg, Mont.; K. M. Leute, president, General Manganese Corp., New York; Leslie L. Savage, president, U. & S. Mining & Development Co., New York; James W. Gerard, New York; Col. George W. Steele, president, Brunswick Terminal & Railways Securities Co., New York; Wilson Bradley, president, Bradley-Fitch Co., Deerwood, Minn.; C. L. Berrien, general superintendent of mines, Anaconda Copper Mining Co., Butte; G. P. Goodier, president, New Mexico Copper and Mining Co., Denver; Homer C. Chapin, Chapin Exploration Co., Chicago; M. C. Lake, geologist, Duluth.

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WITH THE MANUFACTURERS

New Design Increases Utility of Cardox Shell

For two years or more the "Cardox" method of coal production has made steady progress, and this means for bringing down coal at the face is in successful every-day use in several of the coal-producing states from West Virginia to Colorado. This method has been approved by the U. S. Bureau of Mines as being safe for use in explosive mixtures of methane and air, and because of the comparatively low pressure at which the gas is released the coal is brought down in larger pieces.

In the past one of the chief objections to the use of this method of coal production has been the size and weight of the shell employed. This has now been largely overcome by the development of a new design, much smaller and lighter than the original yet capable of doing an equal amount of work.

The original shell was roughly 4 in. in diameter, 39 in. long, held 122 cu. in. of liquid gas and weighed when loaded about 85 lbs. The new or Type G shell is 3 in. in diameter, 34 in. long, holds 80 cu. in. of liquid carbon dioxide and weighs when loaded about 40 lbs.

The reason why 80 cu. in. of liquid gas in the new shell is capable of doing approximately as much work as 122 cu. in. in the older one is that in the new shell the gas upon detonation is not only evaporated but superheated. The energy available from it is, therefore, approximately the same in the one case as in the other. Care is taken, however, to be certain that its temperature at release is well below the ignition point of methane. This renders the shell safe to use in explosive mixtures of fire damp and air.

The new shell is simple and rugged in design, its comparatively few component parts being husky and strong. The smaller diameter as compared with the older design will mean a decreased power consumption and lesser cost entailed in drilling. Stemming material will be less in quantity, easier to place, and more effective. Labor of charging, handling and transporting will naturally be roughly proportional to the weight.

The primary advantage, however, is the fact the new shell is smaller, lighter and easier to handle than the older one, yet is capable of delivering approximately an equal "kick."

A New High Capacity, Semi-Revolving Electric Shovel

For a period of 30 years, up to 1910, the railroad type shovel was supreme in the power excavating field. As our great mining fields developed and new economic obstacles were encountered it became necessary to develop a larger excavator—the large, full revolving, type—embodying enormous range and capacity, the first of which was built and shipped by The Marion Steam Shovel Company in 1911.

Recently the problems of several fields, particularly the iron mining operations, have raised new economic conditions and there has been an undoubted trend to and demand for an entirely different type of power excavator—a high capacity, low maintenance shovel.

The large "strippers" will undoubtedly always be required for material that may be immediately "spoiled." For this, these machines are superior to any other type. But where speed, high capacity, accuracy of loading and ease of handling enter in, they are too large and cumbersome.

The new Marion Type 6200 was designed with this in mind and yet retain a higher capacity. To get a machine of this type it has been necessary to create an altogether new type of machine.

Speed has been obtained in two ways: first by having a minimum of rotating parts, only the boom, dipper and handle, and hoist machinery rotate as against the full revolving machine. Second, the entire hoisting unit is mounted on the swing circle, eliminating the old chain hoist with its accompanying sheaves, etc. These two features permit a rapid hoist, fast swinging, and because of the low inertia, easy controlling and "spotting." Since rotating and hoisting are the major operations to be performed the operating cycle has been speeded up by 20 percent over the lighter and smaller 4-cu. yd. revolving machines.

The standard equipment of the type 6200 will be a 5-cu. yd. dipper. This size combined with other features will permit "grading" of the ore or other material in the pit.

Another important improvement is the crawling traction equipment and propelling machinery. Heretofore all power excavators have depended on the hoist machinery for motive power in propelling. The type 6200 is equipped with an entirely separate propelling unit mounted rigidly on the lower frame (as distinguished from the swinging circle) and under separate control. The power from the motor is conveyed through a gear train to two semi-rigid crawlers. These crawlers have a three-point bearing to allow for inequalities of the pit floor but otherwise are similar to the rigid crawlers of the small revolving shovels.

Because of the improvements in design it has been possible to give this new shovel a larger swinging arc than was possible on the railroad types. The 220-degree swing will permit digging or loading far back of the center line of rotation and three ore cars can be loaded at a time without re-spotting the cars.

New Westinghouse "Weldomatic"

The Westinghouse Electric and Manufacturing Company announces the development of the "Weldomatic," a new and improved automatic welding outfit. The Weldomatic equipment is complete with electrode feeding device, control cabinet and operator's panel. It is designed to operate with equal satisfaction from either Westinghouse variable voltage or constant voltage welding motor generator sets.

The growth and economy of automatic arc welding in the metal working industries has brought about a demand for an automatic welder of very compact dimensions to facilitate mounting on the welding tools, and furthermore, a welding device that is equal in reliability of the usual shop tool.

The Weldomatic has been developed by the Westinghouse Electric and Manufacturing Company to meet these conditions. It automatically strikes and holds an arc between an electrode and the work to be welded without the aid of an operator other than to press the starting button. The feeding device is a most compact design which permits its ready application to work handling tools. The drive motor is mounted in a cylindrical fram which supports the nozzle assembly. The nozzle has adjustments for being moved in two planes, and the nozzle assembly can be reversed very easily to be either a right hand or a left hand assembly.

Gardner-Denver Erecting Addition To Quincy, Ill., Plant

Contracts were let recently for the new building addition of the Gardner-Denver Company plant at Quincy, Ill. This will give a 50 percent increase in production and it is to be finished by December 1.

Unfilled orders of the company have not diminished, it was announced by Raiph G. Gardner, vice president. With the additional manufacturing space this fall, production will soon be much nearer the sales demand, he said.

Two foreign branch managers of the Gardner-Denver Company left the United States recently to take charge of their respective offices.

Ralph Scott, formerly sales manager of the drill division of the company, is enroute to London where he is to be stationed permanently. W. G. Agnew, who was until recently the Gardner-Denver sales representative in Arizona, leaves for Lima, Peru, to take charge of the office there.

The Gardner-Denver Company manufactures rock drills, air compressor slush pumps, drill sharpeners, high pressure drill steel forges and kindred machinery. Its main plants are located in Denver, Colo.; Quincy, Ill., and La Grange, Mo.

New Limit Switch Has Universal Application

The General Electric Company announces a new cam-operated limit switch for industrial control applications which supersedes the various older types which that company has been manufacturing and combined all their advantages in one device. It is also very low in price. It bears the designation LS-438.

The new switch is enclosed in a cast case. Electrically it is a two-circuit switch that, by a simple adjustment, can be made either normally open or normally closed, or one circuit open and one closed. It is a snap-action, cam-operated device and can be obtained with either spring or star-wheel return with any one of four operating levers: a roller lever with a 1- or 3-inch roller, a forked lever or a straight lever. The contact tips are interchangeable with those of standard General Electric cam-operated master and geared limit switches.

A new Linde Oxygen plant located at 1628 Cascade Street, Erie, Pa., commenced operations August 21. This plant will supply the local demand for oxygen, widely used for oxy-acetylene welding and cutting. J. J. McKeen is superintendent of this plant and R. S. Hamilton, whose headquarters are at the East Buffalo Line plant, is district superintendent.

Koppers-Rheolaveur Opening Office In Huntington

Koppers-Rheolaveur Company are opening an office October 1 in the First National Bank Bldg., Huntington, W. Va., with C. L. Miller in charge. This office will handle the growing business in tipple construction and coal cleaning equipment in southern West Virginia, Virginia and eastern Kentucky.

Hercules Plans Construction of New Experimental and Chemical Research Laboratories

Plans for the erection near Wilmington of a new experimental station consisting of experimental and chemical research laboratories were announced recently by officials of the Hercules Powder Company, manufacturers of explosives, naval stores, nitrocellulose and cellulose.

Following the erection of structures now being designed the experimental staff and research equipment will be moved here from Kenvil, N. J., the present site.

Construction will consist of a main building, containing chemical laboratories, offices and library, and auxiliary buildings housing experimental plants. A power house and store rooms will also be erected. At the present station about 120 people are employed of whom more than half are technically trained chemists, physicists, and engineers.

Removal of the Hercules experimental work to Wilmington will bring it into closer contact with the main office organization, facilitating the technical service the company offers users of explosives, cellulose, nitrocellulose, and naval stores (turpentine, rosin, pine oil). The Hercules company has carried on extensive experimental research work for a number of years.

Officials of Allen & Garcia Company and the Soviet Institute for Designing of Mines closing a contract for technical assistance which the former is to give in design and construction of shafts in Russian coal fields. Seated, left to right—N. Levchenko vice president of the Donugol Coal Trust; S. G. Bron, Amtorg Trading Corp.; Messrs. Allen and Garcia, of the Allen & Garcia Company, of Chicago.

Allen & Garcia Signs Contract With Soviet Coal Trust

The Amtorg Trading Corporation has announced the signing of a new contract for technical assistance in the Soviet coal industry with the Allen & Garcia Company, of Chicago. The contract, concluded by N. Levchenko, vice president of the Donugol Coal Trust, and representative of Gyproshacht, the Soviet Institute for Designing of Mines, calls for technical assistance in the design and construction of new coal shafts in the Donetz Basin and in Siberia.

Thirty-five American engineers will be sent by the Allen & Garcia Company to work with the Gyproshacht on the various projects now under way. Twenty of these engineers will be located at Kharkov, in the Ukraine, and 15 at Tomsk, in the Kuznetz Basin of Siberia. This will constitute the largest group of American engineers to work in any single industry in the Soviet Union.

Saul G. Bron, chairman of the Board of Directors of the Amtorg Trading Corporation, in commenting upon the new agreement, which brings the total number of technical assistance contracts with American firms to 28, stated: "With the putting into operation of this agreement, the coal industry of the Soviet Union, which is undergoing a very large expansion, will employ the services of three leading American mining engineering firms. Aside from the Allen & Garcia Company, Stuart, James & Cooke and the Roberts & Schaefer Company are assisting the Soviet Coal Trusts in realizing their ambitious program, which calls for an increase in coal production of from 35,000,000 tons last year to 75,000,000 tons in 1933. The Soviet coal industry has made large purchases in the American equipment market, and the developments which are taking place in the industry, with the assistance of American concerns, will undoubtedly serve to enhance the position of American mining machinery in the Soviet coal fields."

Mr. Garcia, who visited the Soviet Union nearly two years ago, as the head of a delegation of five American coal mining engineers, stated yesterday that the present contract grew out of that visit, and that he and Mr. Allen expect to visit the Soviet Union at least once a year to supervise the work of their engineers.

The Allen & Garcia Company are the builders of the Orient Mine in Franklin County, Illinois, which is reputed to be the largest coal mine in the world, and of several other important coal projects.

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CP Rock Bit for Drilling Oil Wells

The Chicago Pneumatic Tool Company has recently perfected a new rock bit for drilling oil wells, which will be known as the CP "Tucone" rock bit. Exhaustive tests by numerous oil producing companies in several fields, show conclusively that this bit costs less to maintain, drills as fast or faster, requires less time in getting in and out of hole, eliminates reaming and produces straighter hole. It will be exhibited for the first time at the International Petroleum Exposition, Tulsa, Okla., October 5-12. The complete bit consists of a one-piece manganese steel casting reamer body and a one-piece manganese steel casting bit body. The construction of the reamer body is such as to permit the placing of the three separate reamer cutters at the proper distance for best alignment and efficient reaming. These reamer cutters, made from chrome nickel steel, heat-treated and hardened, rotate on a bearing held in the reamer body by a bearing pin. The two cutting cones are so inserted in the bit body that they alone stand the brunt of the drilling action and, though they become worn, the bit body itself is unaffected. The cutting cones have deep cut teeth, designed to meet various conditions. The cone is mounted on an extra large bearing and this unit (consisting of cutting cone mounted on bearing) is held securely in the bit body by a washer, nut, lock nut and cotter pin which are easily removable. The complete cutting cone unit can be removed and replaced with a new unit in 20 minutes. Another new feature of considerable economic importance to drillers consists of an unusual cone-replacement service. The cutting cone and its bearing are one unit and are never sold separately. When a cone is worn, the unit is removed and sent to any one of numerous licensed CP service stations where the worn cone is stripped from its bearing and a new factory-made CP cone refitted on the same bearing.

Production is under way and the manufacturers expect to be able to begin delivery in various sizes from 5⅝-in. to 17¼-in. diameter, in a few weeks. An illustrated and descriptive folder will be sent upon request to the company at 6 East 44th Street, New York City.

New Sullivan Concrete and Clay Tools

Two bulletins just issued by the Sullivan Machinery Company describe improved compressed air concrete breakers and clay spaders.

Bulletin 87-A describes the "M-1" 1929 model clay spader and is eight pages in extent, printed in two colors. The "M-1" spaders weigh 25½ pounds and may be equipped with several different types of handles and throttles, including single and double grip handles, and palm trigger, finger grip trigger, and push throttle handles.

The bulletin is illustrated with numerous pictures of spaders operating under different conditions of work, both above ground and in tunnel excavations.

Sullivan Concrete Breakers and Pile Hammers

(Bulletin 87-B, eight pages)

The adaptability of the Sullivan "K-2" buster has been demonstrated by extended use in many parts of the country. The "K-4" heavy duty buster is a more recent development. This tool weighs 84 lbs. and is recommended for unusually heavy tasks such as demolition of steel reinforced concrete in either pavements or in foundation removal, etc. The variety of work on which these concrete breakers can be employed is constantly increasing and include not only the tasks mentioned above, but such work as cutting asphalt, wrecking buildings, old retaining walls, etc., digging hardpan, shale, or frozen ground, back-fill tamping in trenches, shallow rock drilling, and sheet pile driving.

Changes In Link-Belt Personnel

From the executive offices of the Link-Belt Company comes the announcement of the resignation of F. B. Caldwell, vice president of the Chicago Plant, on account of health.

W. C. Carter, formerly vice president in general charge of production at all Link-Belt plants, will assume the duties of vice president and general manager of the Chicago Plant.

E. J. Burnell, who was manager of the Pittsburgh office, has been appointed sales manager of the Western Division, with headquarters at the Chicago Plant.

Nels Davis, from the Chicago engineering sales force, succeeds Mr. Burnell as manager of Link-Belt's Pittsburgh office.

American Rolling Mill Plant To Get Oil-Electric Locomotives

The American Rolling Mill Company has ordered two more 300-hp. oil-electric locomotives for use in their Ashland, Ky., plant. These units are to be duplicates of the four already in service, and are built jointly by the Ingersoll-Rand Company, General Electric Company, and the American Locomotive Company.

Many oil-electric locomotives are now in constant service on railroads and in industrial plants throughout the country. Their fuel, operating and maintenance costs are very low, and they are performing service over 90 percent of the calendar hours in the year.

New Manager of Du Pont Explosives Department

John W. McCoy, formerly assistant general manager of the Explosives Department of the du Pont Company, has been appointed general manager, vice J. Thompson Brown, who has been elected a member of the executive committee of the company. Edward B. Yancey, formerly manager of the Birmingham plant, and who for more than a year past has been acting in an executive capacity at the home office, has been made assistant general manager of the department.

American Chain Company Moves To New Quarters

Removal of the Chicago offices of the American Chain Company, Inc., and Associate Companies on September 28, to new quarters on the seventeenth floor of the Chicago Daily News Building, Room 1765, has been announced.

This move on the part of the American Chain Company, who are makers of a complete line of welded and weldless chain as well as many other specialties, further centralizes the Chicago offices of several of the companies associated with it. The associated companies affected include Ford Chain Block Company, Highland Iron and Steel Company, The Manley Manufacturing Company, Page Steel and Wire Company, Reading Steel Casting Company, and Wright Manufacturing Company.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912,

Of The Mining Congress Journal, published monthly at Washington, D. C., for October 1, 1929.

City of Washington,
District of Columbia, ss:

Before me, a notary public in and for the state and county aforesaid, personally appeared R. S. Mowatt, who, having been duly sworn according to law, deposes and says that she is the assistant business manager of The Mining Congress Journal, and that the following is, to the best of her knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 411, Postal Laws and Regulations, printed on the reverse side of this form, to wit:

1. That the names and addresses of the publisher, editor, and business managers are:
Name of publisher, The American Mining Congress; post-office address, Washington, D. C.

Editor, E. R. Coombes.

2. That the owners are: The American Mining Congress—a corporation, not for profit. No stockholders. President, Robert E. Tally, Clarkdale, Ariz. First vice president, William H. Lindsey, Nashville, Tenn. Second vice president, Jesse F. McDonald, Denver, Colo. Third vice president, S. Livingston Mather, Cleveland, Ohio. Secretary, J. F. Callbreath, Washington, D. C.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

R. S. Mowatt,
Assistant Business Manager.

Sworn to and subscribed before me this 21st day of September, 1929.

[seal] Thomas C. Willis.
(My commission expires January 4, 1932.)

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THE CLEVELAND-CLIFFS IRON CO · CLEVELAND · OHIO

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An empty ore steamer returns to the loading docks . . . slowly it moves in alongside the chutes, a long row that stand like soldiers in line at silent, impatient attention. A quiver—a movement—then scarcely before the boat is made fast, the chutes drop—one . . . two . . . five . . . ten . . . twenty . . . thirty. A wild rush of iron ore, ton upon ton loads into the hold—10,000 tons with a few hours. The chutes lift upward again to their places—another ore freighter is ready to go.

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THE CLEVELAND-CLIFFS IRON CO · CLEVELAND · OHIO

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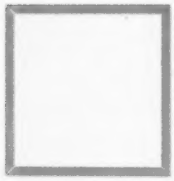

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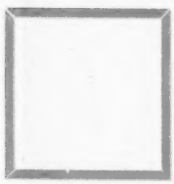

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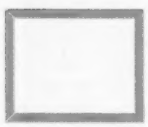

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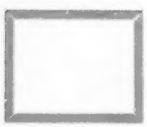

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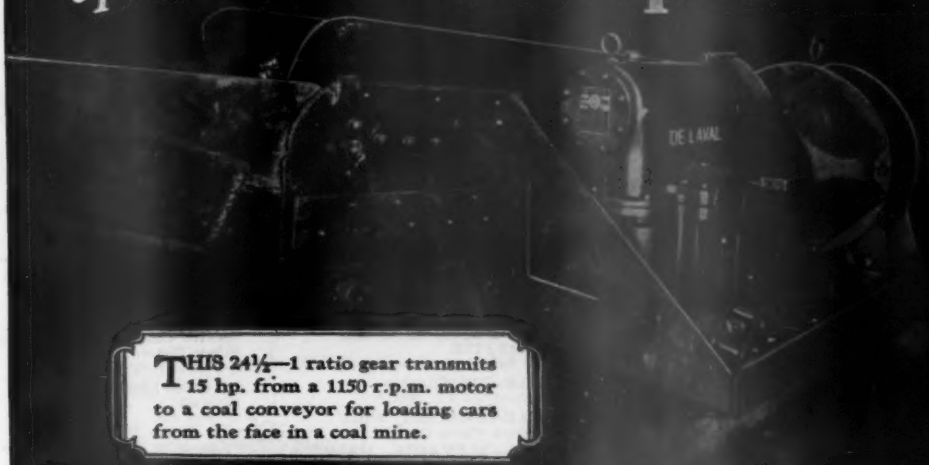

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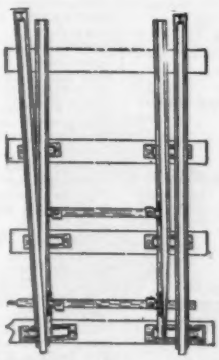

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COAL CONVEYING MACHINERY
American Coal Cleaning Corpn.
Conveyor Sales Co.
Link-Belt Co.

COAL CRUSHERS
Connellsville Mfg. & Mine Supply Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

COAL CRUSHERS & ROLLS
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Link-Belt Co.
Vulcan Iron Works.

COAL CUTTERS
Goodman Mfg. Co.
Ingersoll-Rand Co.
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COAL HANDLING MACHINERY
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The Jeffrey Mfg. Co.
Joy Manufacturing Co.
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Mining Safety Device Co.
Roberts & Schaefer Co.
Westinghouse Electric & Mfg. Co.

COAL LOADERS
Conveyor Sales Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Joy Manufacturing Co.
Link-Belt Co.
Sullivan Machinery Co.

COAL MINING MACHINERY
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Sullivan Machinery Co.
Westinghouse Electric & Mfg. Co.

COAL MINING PLANTS
American Coal Cleaning Corpn.
Goodman Mfg. Co.
Ingersoll-Rand Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.

COAL PREPARATION MACHINERY
American Coal Cleaning Corpn.
Link-Belt Co.
Roberts & Schaefer Co.

COAL SEPARATING MACHINERY
W. S. Tyler Co.

COAL SEPARATORS (Pneumatic)
American Coal Cleaning Corpn.
Roberts & Schaefer Co.

COAL SEPARATORS (Spiralizers)
Link-Belt Co.

COAL TESTING EQUIPMENT
W. S. Tyler Co.

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Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.
Sullivan Machinery Co.

COMPRESSORS, MINE CAR
Ingersoll-Rand Co.
Sullivan Machinery Co.

CONCENTRATORS (Table)
Allis-Chalmers Mfg. Co.

CONCRETE REINFORCEMENT
American Steel & Wire Co.

CONDENSERS
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Ingersoll-Rand Co.
Westinghouse Electric & Mfg. Co.

CONTROLLERS
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Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.

CONVERTERS, COPPER
Allis-Chalmers Mfg. Co.
Westinghouse Electric & Mfg. Co.

CONVEYORS
American Coal Cleaning Corpn.
Conveyor Sales Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Roberts & Schaefer Co.
United Iron Works, Inc.

CONVEYOR BEARINGS
Link-Belt Co.

CONVEYORS, BELT
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.

CONVEYORS, CHAIN FLIGHT
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.

CONVEYORS, COAL
American Coal Cleaning Corpn.
Conveyor Sales Co.
The Jeffrey Mfg. Co.
Link-Belt Co.
Vulcan Iron Works.

CONVEYORS AND ELEVATORS
Allis-Chalmers Mfg. Co.
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.

CONVEYORS, PAN OR APRON
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.

CONVEYORS, SCREW
American Coal Cleaning Corpn.
The Jeffrey Mfg. Co.
Link-Belt Co.

COOLERS (Man)
Robinson Ventilating Co.

COOLERS, ROTARY
Vulcan Iron Works.

COPPER WIRE & STRAND (Bare)
American Steel & Wire Co.
Roebling's Sons Co., J. A.

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American Cable Co.

CORE DRILLS, Carbon (Diamonds) for
R. S. Patrick.

CORE DRILLING
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Pennsylvania Drilling Co.

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Link-Belt Co.
Westinghouse Electric & Mfg. Co.

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Ayer & Lord Tie Co.

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Central Frog & Switch Co.
West Virginia Rail Co.

CROSSOVERS
Central Frog & Switch Co.

CROSS TIES, CREOSOTE TREATED
Ayer & Lord Tie Co.

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Standard Oil Co. (Ind.)

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The Jeffrey Mfg. Co.
United Iron Works, Inc.

CRUSHERS (Coal)
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The Jeffrey Mfg. Co.
Link-Belt Co.
Vulcan Iron Works.

CRUSHERS, SINGLE and DOUBLE ROLL
Allis-Chalmers Mfg. Co.
The Jeffrey Mfg. Co.
Link-Belt Co.

CRUSHING PLANTS, COKE
The Jeffrey Mfg. Co.
Link-Belt Co.

CRYSTAL (Quartz)
Diamond Drill Carbon Co.

CUP GREASE
Keystone Lubricating Co.
Standard Oil Co. (Ind.)

CUTTING APPARATUS, Oxy-Acetylene, Oxy-Hydrogen
Oxweld Acetylene Co.

CYCLONE DUST COLLECTORS
American Coal Cleaning Corpn.

DECARBONIZING APPARATUS
Oxweld Acetylene Co.

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American Coal Cleaning Corpn.
Koppers-Rheolaveur Co.
Link-Belt Co.
Roberts & Schaefer Co.

DETONATORS
E. I. du Pont de Nemours & Co.
Hercules Powder Co.

DIAMOND CORE DRILL CONTRACTING
Hoffman Bros. Drilling Co.
Sullivan Machinery Co.

DIAMOND DRILLING CARBON
Diamond Drill Carbon Co.
R. S. Patrick.

DIAMONDS, BLACK (See Carbon and Borts)
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R. S. Patrick.

DIAMONDS, INDUSTRIAL
Diamond Drill Carbon Co.
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Diamond Drill Carbon Co.

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Standard Oil Co. (Ind.)

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Ingersoll-Rand Co.

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American Mine Door Co.

DRIFTERS, DRILL
Ingersoll-Rand Co.
Sullivan Machinery Co.

DRILLERS' DIAMONDS
Diamond Drill Carbon Co.

DRILLING CONTRACTORS
Pennsylvania Drilling Co.
Sullivan Machinery Co.

DRILLING, DIAMONDS for
Diamond Drill Carbon Co.
R. S. Patrick.

DRILLS, AIR AND STEAM
Ingersoll-Rand Co.

DRILLS (Blast Hole)
Ingersoll-Rand Co.

DRILL BITS, Carbon (Diamonds) for
Diamond Drill Carbon Co.
R. S Patrick.

DRILL, CARBON (Diamonds) for
Diamond Drill Carbon Co.
R. S. Patrick.

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Sullivan Machinery Co.

DRILL LUBRICANTS
Standard Oil Co. (Ind.)

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DRILLS, HAMMER
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Sullivan Machinery Co.

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DRILLS, PNEUMATIC
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DRILLS, PROSPECTING
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Ingersoll-Rand Co.

DRILLS, ROCK
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DRYERS, ROTARY
Vulcan Iron Works.

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Link-Belt Co.
Mining Safety Device Co.
Phillips Mine & Mill Supply Co.
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American Coal Cleaning Corpn.

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Hercules Powder Co.

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General Electric Co.
Goodman Mfg. Co.
Westinghouse Electric & Mfg. Co.

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Ohio Brass Co.
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American Steel & Wire Co.

ELECTRICAL SUPPLIES
General Electric Co.
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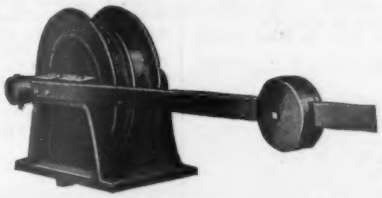

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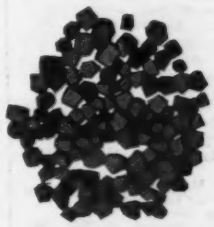

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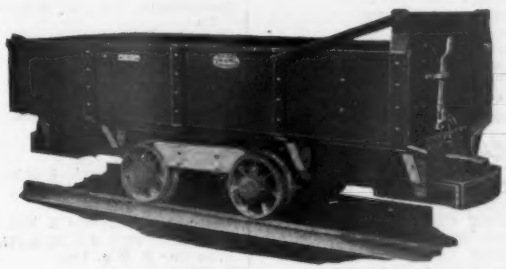

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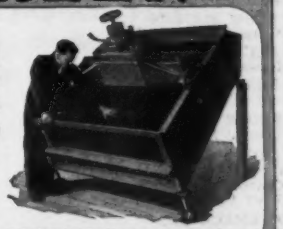

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Joy Manufacturing Co.
LOADERS, Truck
Joy Manufacturing Co.
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The Jeffrey Mfg. Co.
Westinghouse Electric & Mfg. Co.
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Goodman Mfg. Co.
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Vulcan Iron Works.
LOCOMOTIVES, STORAGE BATTERY
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General Electric Co.
Goodman Mfg. Co.
The Jeffrey Mfg. Co.
Vulcan Iron Works.
Westinghouse Electric & Mfg. Co.
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Goodman Mfg. Co.
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LUBRICATING DEVICES
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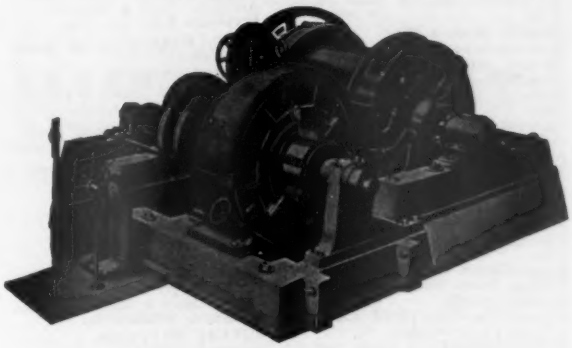

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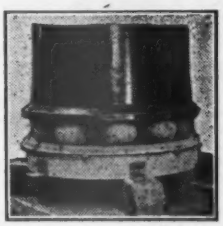

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WELL DRILLS, for Water, Well and Gas
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WHEELS, Cast Iron
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Hockensmith Wheel & Mine Car Co.

WHEELS, Roller Bearing
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WIRE ROPE, Crescent Brand Ordinary
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PROPOSED DEVELOPMENTS

of This Standard

Under the chairmanship of Mr. W. W. Graff, Superintendent, Negaunee District, Cleveland-Cliffs Iron Company, it is proposed to develop the following standards. The work is to be conducted by three sub-committees now being organized:

Sub-Committee No. 1—Tracks.
Sub-Committee No. 2—Cars.
Sub-Committee No. 3—Practice.

AMERICAN RECOMMENDED PRACTICE

UNDERGROUND TRANSPORTATION IN METAL MINES

M-18—A. S. A.
Approved May 26, 1928.

Section I. Hand Tramming

(a) SIZE AND TYPE OF CAR.	Roller bearing, box-shaped, end dump, 20 cubic feet capacity.
(b) GAUGE OF TRACK.	18 inches.
(c) WEIGHT OF RAIL.	16 pounds.
(d) GRADE OF TRACK.	.5 per cent.
(e) DIMENSIONS OF DRIFT.	5′ x 7′ in the clear.
(f) SIZE OF CHUTE.	The size and type of chute and door will vary materially with weight and character of material and method of mining, and, for this reason, no tentative standard is submitted.

Section II. Motor Haulage.

(a) SIZE AND TYPE OF CAR.	Roller bearing, side dump, not less than 3 tons capacity.
(b) GAUGE OF TRACK.	30 inches.
(c) WEIGHT OF RAILS.	50 pounds.
(d) GRADE OF TRACK.	Not more than .5 per cent.
(e) DIMENSIONS OF DRIFT.	8′ x 8′ in the clear.
(f) SIZE OF CHUTE.	The size and type of chute and door will vary materially with weight and character of material and method of mining, and, for this reason, no tentative standard is submitted.
(g) WEIGHT OF LOCOMOTIVE.	6 tons.

For long tunnel haulage, cars of 10 tons capacity, with gauge of track, weight of rail, size of drift and weight of locomotive to correspond are recommended.

MOTOR HAULAGE

Size of Car.

Capacity—3 tons or larger.
— cu. ft.
Height above rail —
Width —
Gauge of wheels—30 inches.
Diameter of wheels —
Size of flange —
Width of tread —
Size of axles —
Length of hub —
Wheel-base —
Type of coupler —
Type of draught gear —
Height of center-line of draw-head above rail —
Size of springs —

Track.

Gauge—30 inches.
Weight of rail—40 lbs. or heavier.
(Standardize on sizes of rail for different weights or capacities of cars.)
Spacing of holes in fish-plates and rails —
Size of holes in fish-plates and rails —
Size of track-bolts —
Size and type of fish-plates or angle-bars —
Size of ties —
Spacing of ties —
Size of track-bolts —
Tie-plates —

Switches.

Radius of curvature for turnouts —
Type switch recommended —
Length of lead for switches, and details of switches —
Type and number of frog —
Standard radii of curves —
Minimum radius of curves —
Type of switch stand —
Light signals at switches —
Block-signals —

Locomotives.

Size—6 tons.
Gauge—30 inches.
Draw-heads and couplers —
Voltage for trolley-wire —
Height of trolley-wire above rail —
Guards for trolley-wire at Chutes —
Lights on locomotives —
Warning signals—bells—horns, etc. —
Jacks and rerailers—etc., standard equipment.

HAND-TRAMMING

Size of Car.

Capacity—20 cu. ft.
Height above rail —
Width —
Gauge of wheels—18 inches.
Diameter of wheels —
Size of flange —
Width of tread —
Size of axles —
Length of hub —

Track.

Gauge—18 inches.
Weight of rail—16 lb. per yard.
Size of ties —
Spacing of ties —
Size of track-spikes —
Size of fish-plates —
Spacing of holes in fish-plates and rails —
Size of holes in fish-plates and rails —
Size of track-bolts —

Switches.

Radius of curvature for turn-outs —
Length of lead for switches —
Type and number of frog —
Type of switch recommended —
Standard radii of curves —
Minimum radius of curves —

Readers are cordially invited to send in comments or suggestions on each item.

THE AMERICAN MINING CONGRESS

National Standardization Division,
Metal Mining Branch,
841 Munsey Building, Washington, D. C.

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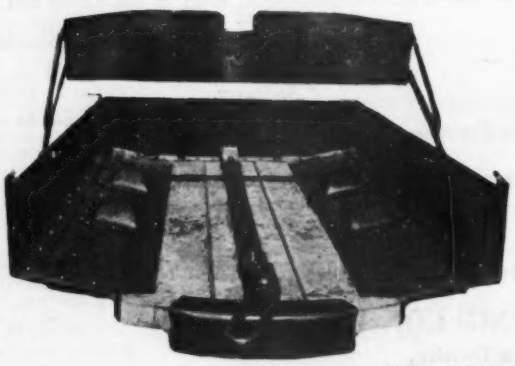

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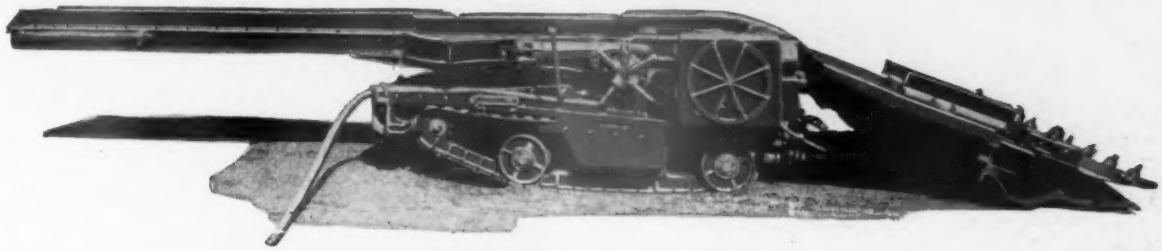

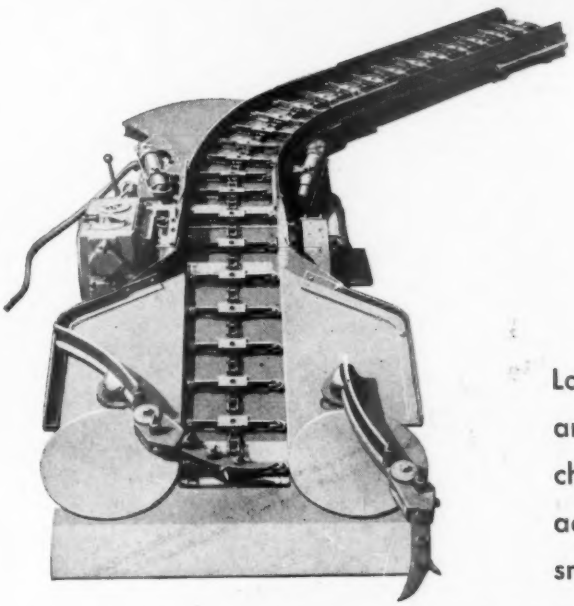

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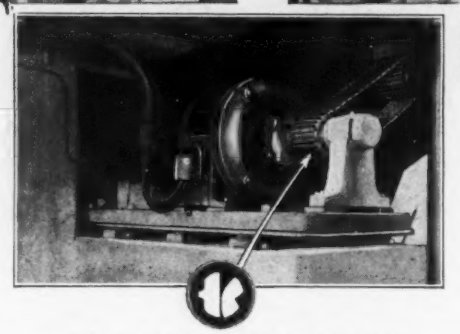

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